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TRAMWAY PROGRESS IN AMERICA AND THE UNITED KINGDOM.

No one acquainted with the history of electric traction requires to be told that America is at the present time much in advance of this country in respect to the number and the extent of traction undertakings in actual operation. The reasons for this state of affairs have often been stated, and need not be repeated here, especially as they are neither flattering to the British Legislature nor pleasing to our national pride. But while it is thus unnecessary to go into matters of past history, we may with advantage consider the present state of electric traction in the two countries, and so be enabled to judge whether we are now making good our former deficiencies or are being left still further behind. As America had a clear start from us of several years, we cannot expect to make up leeway all at once; and perhaps even we should not expect ever to equal that country in the number and extent of electric traction undertakings, for the conditions of life in the two countries are not identical, and the enormous area of the United States compared with that of Great Britain makes it unlikely, if not impossible, that our railways and tramways should ever be as extensive as those on the other side of the Atlantic. Progress, however, is a relative term, and by comparing the present condition with that of former years, both for the United Kingdom and the United States, we may obtain information of considerable interest to the whole community.

A favourable opportunity for at least a partial comparison is offered at the present time by the publication by the United States Census Office of a Census Report on street railways, prepared by Mr. W. M. Stewart, chief statistician of the Division of Manufactures, who has been aided in the compilation of statistics by expert advice from Mr. T. Commerford Martin, editor of our esteemed contemporary the *Electrical World and Engineer*, of New York, and from Prof. E. Dana Durand, formerly of Harvard University, and now special expert of the Bureau of Corporations, Department of Commerce. An abstract of the report has appeared in a recent issue of the American *Street Railway Journal*, and to it we are indebted for the figures relating to American undertakings which appear below. It will be noticed that these only refer to street railways, or what we would call tramways, so that in considering the corresponding position in England we will neglect electric railways proper (as distinct from tramways), and take only tramways and light railways, the latter being in very many cases little different from tramways.

The figures given in the Census Report are for the year ending June 30th, 1902, and by comparing these with the figures of 1890, we find the growth of street railways in 12 years and the extent to which electricity has during that period ousted all other motive powers on these undertakings.

The following table gives the length of lines and of single track for all street railways, irrespective of the kind of tractive force used, in operation in these two years :—

—	1890.	1902.	Percentage increase in 12 years.
Route mileage	5,783·47	16,647·83	187·85
Length of single track in miles	8,123·02	22,589·47	178·09

Thus, over the period of twelve years, there has been an average increase of 15 per cent. per annum in the length of single track over the value for 1890. No doubt the rate of increase has been greater than 15 per cent. in more recent years, as the enthusiasm for electric traction did not come till a considerably later date than 1890, and it is quite clear, as we shall see immediately, that the great increase in mileage is very largely due to the growth of electric traction. The following table shows how the total mileages given above are distributed among the different systems—that is, classified according to the kind of power used on the lines :—

Kind of power.	Length of single track. 1890.	1902.	Percentage increase (+) or decrease (—)
Electric	1,261·97	21,920·07	+ 1,636·97
Animal	5,661·44	259·10	— 95·42
Cable	488·31	240·69	— 50·71
Steam	711·30	169·61	— 76·15

This table shows clearly the remarkable progress of electric traction in the United States during the past twelve years. Even in 1890, the mileage of single track operated electrically was greater than that operated by cable and steam together, but at that time only 15 per cent. of the total mileage belonged to electric systems, animal traction being then far ahead of all its rivals. But twelve years later we find a percentage increase of 1,637 in the electric track mileage, while the other systems have decreased to comparatively insignificant figures, and of the total single-track mileage in 1902, no less than 97 per cent. is operated by electricity. The extensiveness of the system is seen in the fact that nearly 22,000 miles of electric track are in use to-day. The difference made in the traffic by this modern method of traction is seen in the following table, giving the number of passenger cars, and of passengers carried in 1890 and 1902 on all the street railways together :—

	1890.	1902.	Percentage increase.
Passenger cars	32,505	60,290	85·48
No. of fare passengers...	2,023,010,202	4,813,466,001	137·94

These returns are of great interest to all associated with electric traction in this country. They make one thing quite clear—that we cannot hope to rival the United States in the extent of their tramway undertakings. But it is not necessary that we should do so. What is really required is that tramway enterprise in this country should be as fully developed proportionately to the needs of the community. It may be taken for granted now that wherever new tramways are developed, electric traction will be used upon them, and thus tramway progress will now mean the extension of electric traction. Let us consider, then, the actual rate of progress at the present time. It is sufficient for our purpose to take only returns relating to electric tramways, neglecting those concerning horse, cable, or steam-power undertakings, and this course is the more readily adopted in that it is not very easy to obtain complete returns of *all* tramway undertakings in the United Kingdom, while those for electrical undertakings may be readily collected from Mr. Garcke's useful *Manual*.

In the following table we give the route mileage and track mileage for electric tramways and light railways *in operation* in 1890, 1901, and 1902 :—

	1890.	1901.	1902.
Route mileage	25·25	777	1,213
Track mileage	36·25	1,252	1,845
Number of cars	—	3,834	5,310

Could there be a more striking illustration of the enormous lead America obtained over this country in the introduction of electric traction than that supplied by a comparison of the figures in this table with those in the similar table for America? In 1890 the United States had 1,261·97 miles of track on street railways operated by electricity, while the United Kingdom had only 36·25 miles; and 11 years later, in 1901, we had not yet reached the American total for 1890! Overlooking, however, our lateness in starting, and considering only our rate of progress since a start was made, the figures are more satisfactory. The percentage increase in track mileage for 1901, as compared with 1890, is 3,353·7; comparing 1902 with 1890, the percentage increase is 4,989·6. These percentages, however, could not be fairly used as a basis for estimating the average yearly increase, as the values for 1890 are so very small; but we may find the actual percentage increase of last year over the preceding year, and thus obtain a more satisfactory figure. The percentage increase of track mileage for 1902 over that for 1901 is 47·36; and it is therefore obvious that at present very rapid progress is being made. And it seems certain that we may expect this progress to be maintained for some years to come, for in 1902, besides these 1,845 miles of track in actual operation, there were 768 miles under construction, and no less than 2,102 miles either authorised by Parliament or to be converted from other methods of traction. Thus much is being done to make up for lost time, and if only the legislative restrictions, which lead to so much injustice and obstruction, were removed, we should, no doubt, see a very considerable increase in the rate of progress. For the present we must make the best of the law as it stands, and we can only hope that, as the advantages of electric traction to a community become more and more apparent, the local authorities will cease to obstruct progress by the improper exercise of their veto, and will rather show a desire to advance the welfare of their citizens by doing what they can to bring these advantages to their own areas.

A Wireless Telegraphy Confession.

Prof. J. A. Fleming, through his very intimate association with Mr. Marconi and his company, ought to know the prospects of trans-Atlantic wireless telegraphy. The cessation in the trans-oceanic service was weeks ago attributed to a slight and easily remediable mechanical breakdown, but the *Times* has still to wait. The Electrical Review and others in search of the truth have requested fuller details of what has actually been done, and the Postmaster-General on March 31st asked to be satisfied that he was wrong in disputing that the company were in a position to carry on their business and transmit messages from one side of the Atlantic to the other; but he informed the House of Commons on Monday, June 8th, that he was still awaiting this proof. Now we take these facts and read them in connection with the remarks which are attributed to Prof. Fleming (see our "Telegraph Notes" to-day) to the effect that Marconi telegraphy will not interfere with the work done by the submarine cables or the land telegraphs; "it will perform in the future a service of its own, and one which

could not be done by telegraphy by wires." Really this is the most startling confession that has yet come from the lips of a Marconian apostle, and it speaks volumes. Marconian tactics hitherto have been to suggest that wireless messages were soon to be sent across the Atlantic at a rate which would not leave the old-fashioned cables the ghost of a chance. Our readers will remember that all such prophecies and sensational promises have been estimated at their real value in this journal; but, unfortunately, the newspaper press, and in consequence the general public, through their natural lack of knowledge of the matter, have been grossly led astray. Are we to infer from Prof. Fleming's statement that there is to be no commercial trans-Atlantic Marconigraphy after all? Wireless telegraphy is only to do what the cable cannot do. Obviously, then, if the existing deep-sea cables are able to cope with the traffic, Mr. Marconi will consider his services unnecessary. The cables, too, have for many years shown that they can convey a reliable news service to the *Times* and every other newspaper that requires it. Is the *Times* "By Marconigraph" arrangement therefore at an end?

Electric Tramway Services.

It cannot but be apparent to all who give their careful consideration to electric tramway statistics that in many quarters not enough attention is paid to the importance of a frequent service. In too many cases those in authority appear to think the great object to be aimed at is the maintaining of a high rate of receipts per car-mile; in fact, they would seem to desire to keep this a double figure, and to shrink from any reduction below the rate of 10d. per car-mile.

It is certain, however, that this end is very often attained at a considerable loss to the undertaking, as everyone on consideration will admit that such a procedure does not allow the most to be made of the brains and material at the disposal of tramway owners. This will readily be seen when we point out that the additional car-mileage entailed by an increased service will only mean a moderate increase in running expenses, since standing charges and managerial expenses will practically be the same whether a frequent service is run or not. From this it is clear that even if the additional service should only yield receipts at the rate of 6d. per car-mile, a very appreciable margin of profit would be left for the energetic owners of the undertaking. We would, in fact, be strongly inclined to find out what service would yield 9d. per car-mile, and then take this as our minimum service against which the managerial and standing charges would be charged. We would then increase the service to such a degree as to give an average yield of 6d. per car-mile for such additional service.

We wish it to be understood that we do not desire the above statements to be accepted as final. Not only would the figures vary according to the traffic and labour conditions of each locality, but the whole idea is merely thrown out as a suggestion, with a view to stimulating inquiry into the interesting question of the proper methods of dealing with the modern traffic problems of electric tramways.

Our Annual Lists.

With this number of the Electrical Review, we present our readers with the first portion of our annual statistical tables, relating to the Electricity Supply Works of the United Kingdom. We have endeavoured to increase the usefulness and accuracy of the tables by delaying their issue beyond the close of the financial year, which in most cases ends on March 31st or May 15th, so that the tabulated results of the past year's working may be as closely up to date as possible. We offer our cordial thanks to the engineers and managers who have kindly furnished us with data, and we trust that they may be to some extent repaid by the increased utility of the tables.

THE DEVELOPMENT OF THE CURRENT INTERRUPTER.

By J. WRIGHT.

The current interrupter, or "break," as it is sometimes familiarly but incompletely termed, is one of the most important accessories of the induction coil proper, in that upon its economic and steady action depends the very nature of the secondary or induced current which the coil is intended to produce. In the earlier days of electricity as a science, when the induction coil was regarded in the light of an experimental piece of apparatus, capable of producing spark discharges between its secondary terminals, or imparting electric shocks to interested investigators, the old-fashioned vibrating spring, with attached armature, consisting of a small piece of soft iron, fitted to its extremity and placed opposite to, but at a short distance from, the end of the core of the coil, was deemed sufficient for all practical purposes; but the rapid advance of modern electrical science, including the development of X-rays and wireless telegraphy, in which two branches the induction coil plays an important part, has exhibited the need for finer adjustments of the rate of "make" and "break," to say nothing of higher rates of interruption than are possible with the crude mechanical device alluded to above. This latter need has been amply filled by the introduction of electrolytic interrupters of the Wehnelt and Caldwell types, and as the subject promises to be of still further interest in the more or less immediate future, the author purposes treating briefly in the paragraphs which follow of the development of this important adjunct from its commencement to the present day.

As already observed above, the very simplest form of interrupter consists of a short soft iron armature A, fig. 1, which may be cylindrical, square, or of any other convenient section, attached to the free or vibrating extremity of a flexible spring S, and so arranged as to be opposite to, but separated by a short air space from, one pole, P, of the induction coil core. A cock-piece, C, carries a platinum-tipped contact screw B, held in position by a lock nut *n*, and

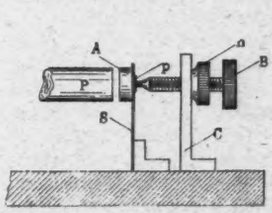


Fig. 1.

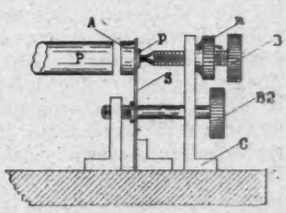


Fig. 2.

with this the spring S makes and breaks contact alternately as it is set in vibration by the electro-magnetic activity of the pole P. The point on S, opposite B, is also platinum-faced, as represented at *p*, in order to ensure an efficient and incorrodible electrical contact. The action of the apparatus is readily understood; the primary circuit of the induction coil is completed through the cock-piece C, screw B, and spring S, which normally rests in contact with it. The core P thus becomes energised, and attracts its armature A, which, carrying with it the spring S, breaks the circuit at *p*, and de-energises the coil, giving rise at the same time to a second current wave in the secondary circuit, the first having been induced by the "making" of the circuit originally. The core P being thus rendered inactive, the armature, under the influence of its spring, flies back, and again makes contact with B at *p*, the cycle of operations being repeated at a rate approximately dependent upon the natural rate of vibration of the spring S.

This is the main and most serious drawback to this otherwise simple device; its rate of interruption, and consequently the frequency, so to speak, of the secondary current waves, depend upon the natural period of vibration of the spring S, which, of course, varies with its thickness or elasticity, and also with the distance between the point of support and the centre of attachment of the armature A.

There is no effective means of adjustment; the contact point of the screw B must always "make" contact with *p* when at rest. Some small adjustment is certainly obtainable by varying the normal pressure of B upon *p*, but such adjustment does not allow of any perceptible variation in the rate of interruption, being rather designed with a view to minimising the destructive sparking at "break" by varying the pressure between B and *p*, according to the current through the primary winding.

Early experience in the practical working of induction coils showed that the duration of the "make" was of equal importance with the brevity of the "break"; in other words, the induced current wave set up in the secondary circuit by completing the primary current of the coil consumed an appreciable time interval in attaining its maximum, whilst the inverse current wave, set up by the "break," was extremely brief, and, in point of fact, died away almost instantaneously, thus calling for immediate action in severing the primary circuit in order to be ready for the next "make," with its maximum induction effect.

Bearing these facts in mind, Mr. Alfred Apps, whose name will be familiar to readers in connection with the historical induction coil constructed by him, instituted a series of investigations into the subject, and in 1867 brought out a modified form of interrupter, in which the required inequality in the intervals of make and break was, to a certain extent, secured.

Apps's interrupter, which is represented in fig. 2, consists in the main of a similar construction to that already described and illustrated in fig. 1, with the important addition of a secondary adjusting screw B_2, which, on being turned to the left, or counter-clockwise, increased the normal pressure between the actual contacts B and *p*, thus lessening the rate of vibration of the spring S, and lengthening the make, or contact interval between them.

The material advance in the means of adjustment provided by the Apps interrupter may be gauged from the fact that by simply manipulating the screw, B_2, a range of adjustment, varying, in a coil of average dimensions, from $\frac{1}{4}$ in. to 10 in. of spark length, may be obtained. Further, by a successful blending of the metals which constitute the spring, S, the drawbacks inherent upon an abnormal rise in temperature due to the current passing through the device, which under ordinary conditions would tend to weaken the effect of the spring, are considerably minimised.

The Bowron interrupter, devised by Mr. G. Bowron, exists in two varieties, for large and small coils respectively. The simpler form of interrupter, for small coils, is illustrated in fig. 3, and is of similar construction to the simple mechanical device illustrated in fig. 1, with the exception of the armature, A, which is mounted on a rod, R, upon which it moves laterally as an axis. Its motion in this direction is limited by a spiral spring, S, which controls the normal position of A upon the rod, R. The action of the device, which has for its immediate object the lengthening of the "make" interval, is extremely simple. When the core, P, becomes energised, it attracts the armature, A, which latter at

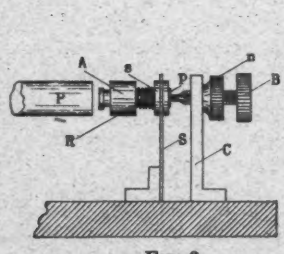


Fig. 3.

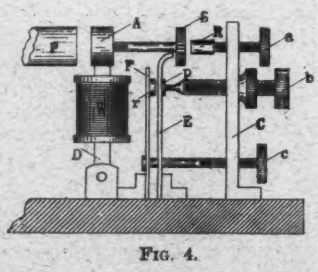


Fig. 4.

first moves along the rod R, exerting tension upon the spring *s*. The latter ultimately overcomes the pressure between the spring S and the contact screw B, with the result that the primary circuit is broken; P then becomes inactive, and both springs resume their normal position ready for a fresh break.

Mr. Bowron's second interrupter, for powerful coils carrying a heavy current, is somewhat more complex, and is represented in fig. 4. A cock-piece, C, carries three screws *a*, *b* and *c*, as shown; P represents the magnetic core of the coil, and A the iron armature as before. The latter is mounted upon a hinged core D, of soft iron, which is also magnetised by a coil W, electrically connected in series with the primary circuit of the induction coil proper. The armature A carries an ebonite-headed screw S, the insulating flange of which abuts against the upper extremity of a vertical spring E, a platinum facing, *p*, on which makes contact with the platinum tip of the screw *b*. F is a second vertical spring placed behind E, and controlled as to its resistance to tension by the screw *c*, which passes through a clearance opening in E. A rubber stop *r* is attached to F at a point opposite the upper extremity of E, and the entire combination of F and *r* serves to regulate the movement of the contact spring E. R is a second rubber pad, attached to the extremity of the screw *a*, which renders it adjustable, and is designed to receive and deaden the back stroke of the armature A. The mode of action will be at once apparent; when the current is first switched on, the armature A is attracted, and flies towards the core P. The ebonite flange of S catches the tip of the spring E, and, after causing it to break contact with *b*, brings it against F, the spring action of which latter is thus added to that of E. The combined action of the two springs throws back the armature, which, in its recoil, strikes the rubber stop R, and is thus checked, ready for the next break. The great advantage of this type of interrupter consists in the equality of contact pressure between *p* and *b*, which, once adjusted by means of the screw *b*, never varies, depending for its severance upon the swing of the arm D and its attached armature.

The "Vril" interrupter is also a typical attempt at prolonging the "make" and curtailing the "break" intervals respectively. Its mechanism is represented by fig. 5, from which it will be seen that the armature A is not attached to

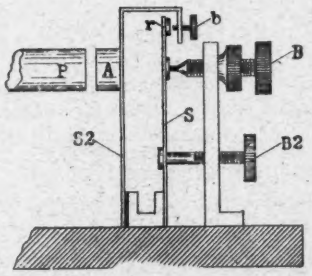


Fig 5.

the contact spring S itself, but to a second parallel spring S_2, which is bent twice at right angles as shown, so that its free extremity overhangs or passes behind the actual contact spring S. An adjustable screw *b*, impinging on a rubber pad *r*, attached to S, transmits the motion of the armature to the latter, but not until after it has travelled a certain distance towards the pole P. The actual "break" is thus quite momentary, and, moreover, a light contact tension only, regulated by the screw B_2, is necessary, thus effecting an appreciable saving in the wear and tear of platinum, no mean consideration when one takes into account the present market value of that commodity.

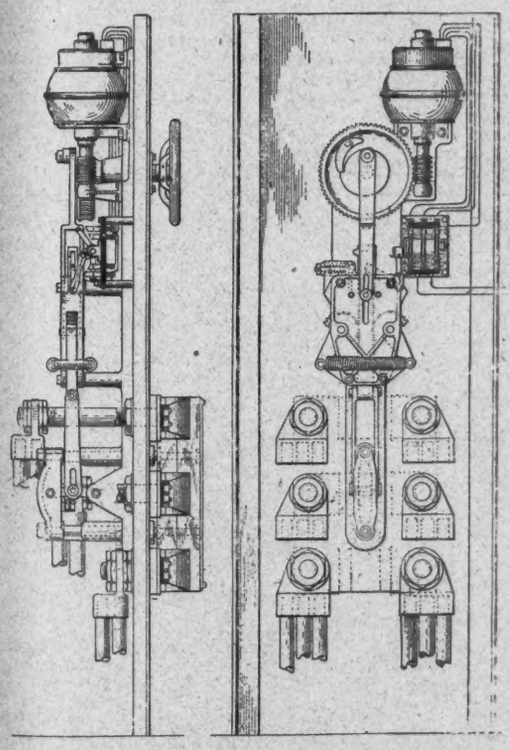
The types of mechanical interrupter so far described have been of so simple a nature as to readily form part and parcel of the induction coil mechanism, receiving the energy required to work them from the coil itself; there are, however, many later forms of current interrupter, mechanical and otherwise, which require the application of extraneous energy, such as that derived from an auxiliary electro-motor, to set them in action.

A form of mechanical interrupter devised for two large induction coils exhibited in New York in 1900, consisted of button-shaped platinum electrodes, immersed in a bath of alcohol; the upper one received a reciprocating motion, communicated by a cam driven by an electro-motor, whilst the lower button was simultaneously rotated at a low rate of speed. This form allowed of a frequency regulation from one to several thousand per second.

(To be continued.)

ELECTRICALLY-OPERATED MAIN SWITCHES.

The standard voltage in isolated plant work in America is still 110 volts. This in large installations involves very heavy mains and switchgear, and special means have frequently to be devised to operate the latter. In the *American Electrician* (February) an illustrated description of the electrical equipment of a large store is given by Chas. E. Knox, in which the means employed to actuate the switchgear is described. The total plant capacity is 2,000 KW. at 110 volts, the generators consisting of units of 200 KW. In order to simplify the switchboard connections, and to avoid bringing heavy equalising cables thereto, it was decided to fix automatic main and equalising switches near the generators, and to operate them by means of auxiliary switches mounted on the main switchboard. The main positive and negative cables had, of course, to be run from the autos. to the main board, but the equalising cables are run between the various machines only, and not to the



EQUALISER SWITCH MECHANISM.

board. The switches are operated through a toggle joint and worm gearing by means of a small electric motor mounted on the back of the switch base, as shown in the illustration above. A two-wire circuit is run from the + and − bars on the switchboard through the auxiliary switches and circuit breakers, to the automatic switches, where it is connected to the motors through small auxiliary circuit interrupting switches.

The function of the latter is to open the motor circuit just before the main contacts are opened (or closed). It is operated through a mechanical connection with the toggle joint. As the toggle (which makes or breaks the main switch contacts) passes over the centre, the auxiliary switch opens and changes over to another set of contacts. The instant the switch opens, the underload circuit breaker on the main board drops out and stops the motor. To open the main switches it is merely necessary to close the small circuit-breaker again, when the motor will run in the same direction as before, and the toggle joint will throw the switches out, the motor being stopped as before, just prior to the switches flying out. The switch may be operated by means of a handwheel in case of need.

LEGAL.

PATENT EXPLOITATION, LTD., v. THE AMERICAN ELECTRICAL NOVELTY AND MANUFACTURING CO., LTD.

(*Continued from page* 953.)

On Tuesday, May 26th, Prof. SILVANUS THOMPSON was further re-examined by Mr. ASTBURY. He did not think Bender's specification would lead an electrician to make a thing like the plaintiffs' invention. If a battery was made as Bender described, it would not have the efficiency of plaintiffs' battery.

Have you ever known of this on the market as an efficient dry cell?—No, I have never come across any cell on the market by the name of Bender, nor any one like this inside.

Now turn to Thiebaut. In your opinion, could anybody in those four papers pick out the plaintiffs' specification?—No.

Is there anything in those papers to tell you what to avoid or what alternatives to choose to get nearer to or further away from the plaintiffs'?—The instructions to avoid are very few. There is only one, I think, and that is the original patent. They were to avoid throwing away the powder.

Do you find any means in those four documents, picking out such of the things as he suggests, that would get you anywhere near the plaintiffs?—No; there is a preference expressed at the end of the third certificate in favour of plaster as against cement or clay, because it expands in setting.

In your opinion, would a cell made in accordance either with the patent or any of these certificates of addition resemble the plaintiffs' battery?—Only superficially. It would not have the good working properties.

Would it be an efficient battery if made in any of those ways?—I think not, and some of them would be very inefficient.

Answering further questions, WITNESS said there was nothing in Germain to indicate whether you were intended to powder your manganese as well as your retort carbon. There was no provision for keeping the cell moist by hygroscopics. Plaintiff's combination or his construction and arrangement were not to be found in Germain's document. There was no suggestion in it of two plastic or semi-solid layers standing by themselves without extraneous aid. In Castle-Smith's specification there was a direction not to use in the outer layer what either the plaintiff or the defendant used.

Mr. ALFRED GORDON SALAMAN, examined by Mr. MOULTON, said he was a consulting and analytical chemist of many years' experience, and until lately had been vice-president of the Institute of Chemistry, and vice-president of the Society of Chemical Industry. He had carefully considered the plaintiffs' specification, and experienced no difficulty in reading his invention from that document. He had carefully examined the documents referred to as alleged anticipations.

Do you find plaintiff's invention, or his combination and arrangement in any one of them?—I find that as a combination the invention of Hitchcock is a complete one. If I look to the alleged anticipations, I find fractions, fragments or portions of that invention in various of the specifications, but, reading it as a whole, I do not find the plaintiffs' invention in any of the alleged anticipations.

Explain to his Lordship what you understand, as a chemist, the invention to be, reading the specification from that point of view.—I read the document to describe a double-layer battery in which there are two electrodes, one of zinc and one of carbon; that surrounding the zinc electrode, which is a circular cup, preferably, there must be a material which is sufficient of a filter to prevent solid matter making its way through it in the form of the depolariser, which must be kept from contact with the zinc; that that layer has got to stand up by itself without support either by way of springs or bands; that that layer must be porous and must be permeated with the excitant, and must have in it a hygroscopic, which, by combination with the excitant, will form a double salt so as to increase the solubility of the excitant, and to lower the freezing point of the excitant salt itself, so that the battery will not freeze, which is attained by means of the zinc chloride added to the ammonium chloride, and that that layer must be in close contact, and continuously in close contact with, the depolarising mixture, which depolarising mixture is made up of a conductor and a non-conductor, which is the depolariser; those two must be in such intimate contact that as the hydrogen is evolved as part of the working of the battery, the depolariser may deal with the hydrogen by becoming itself partially decomposed; the depolariser is made to give up a portion of its excitant, being reduced to the lower oxide of manganese, and in so doing that water must be gathered up by the hygroscopic that is present, and there must also be a sufficiency of absorbent and porosity in the depolarising agent to dissolve and conduct away the ammonia that is formed as part of the decomposition of the electrolyte; that depolariser has to stand up by itself, and it is of great importance that they should be both in this instance in a state of sub-division, and very fine sub-division. The reason is that as hydrogen is given off it must not come in contact for any length of time with the finely powdered carbon; they must be so intermixed that the hydrogen is dealt with by the peroxide of manganese immediately and not permitted to polarise the carbon. Then the carbon rod is placed in that mixture, but the finely-powdered carbon which surrounds the peroxide of manganese enlarges the function of that carbon rod. I think that is substantially, to my mind, a description of the invention.

Examination continued: He thought that for the purposes for which plaster of paris was used in the plaintiffs' specification blotting paper was an equivalent. In support of the statement he produced a cell, into which he put a pulp which was made of the

pulp of blotting paper poured in, and it was there quite a porous material.

Now, for the purposes of this battery, do you think it makes the least difference whether the outer layer is poured in when it is soft or got in if you can do it in the condition in which it has to act in the battery?—So long as it produces the same result, and it is merely a direction how to produce the result so that the battery may function efficiently, I do not think it makes any difference.

Now, will you go to the inner layer? First of all, you notice it is called a compound layer. What do you understand by that?—Reading it as a technologist, I should certainly understand a "compound" to be a mixture. When you compound drugs you mix them. There is no question as to how a chemist would read that word "compound."

We have heard a great deal about the absurdity of putting in a hygroscopic. First of all, defendant has a hygroscopic in all his layers?—Yes; undoubtedly.

You have examined and analysed it?—Yes, I have. It is the same hygroscopic as Hitchcock's.

I think you have made a careful analysis of the defendants' battery?—I have.

In your opinion is it made substantially in accordance with the plaintiffs' specification?—Assuming that the blotting paper, in a moist condition, is an equivalent, as I believe it to be, for the excitant layer of a Hitchcock's specification, then I have no hesitation in saying that it is an equivalent. It is a substantial imitation of Hitchcock's specification.

Is there any function that plaster of paris plays, that flour plays, in the plaintiffs' battery, which the bleaching powder does not play in the defendants' battery?—I know of none.

With that exception, just state the result of your analysis of the defendants' battery.—The battery I analysed consisted of an external cardboard case, a zinc pot, a white layer, a black layer, a carbon rod, and the top was closed by pitch, and there was no vent. The battery consisted of three cells placed one on the top of the other, with an arrangement to keep them together. The black layer or decomposing layer of the cell consisted essentially of manganese peroxide, of ammonium chloride, with traces of iron and lime as impurities, together with ammonium chloride and zinc chloride, which I obtain as an aqueous extract of the black layer.

What about the carbon?—And a residue of carbon.

Is the chloride of ammonia sal-ammoniac?—Yes.

And the chloride of zinc?—Chloride of zinc.

Were the manganese and carbon pulverised or not?—They were both pulverised and substantially equivalent to that which was described in Hitchcock's specification.

Reading the description of Brandon, could you have arrived at the plaintiffs' invention?—Certainly not.

Further examined, WITNESS said that in Skrivanoff of 1882, Walker-Jensen of 1885, Germain, Thiebaut and Bender, he did not find the combination described in the plaintiffs' specification. In Gassner of 1887 and Dymond there was no direction for putting any pulverised or crushed depolariser up against the carbon pole. In Webb and Jensen's complete specification he did not find any direction for arriving at either of the layers in the plaintiffs' specification with hygroscopic or otherwise. The differences were very great.

Cross-examined by Mr. WALTER: He should imagine by the description in the plaintiffs' specification the battery was meant to be one that stood upright. He thought a sandwich battery might be read into the plaintiffs' specification.

As far as the method of construction of the defendants' battery goes, defendants have not followed the method of construction pointed out in the plaintiffs' specification?—Not as regards the method of construction of the battery, but that leads to the same result.

I am not on the question of result. I am on the question of what I am directed to do in the specification. I am told to have a temporary core round which I must pour a fluid, which fluid is afterwards to set. So far, there is nothing of that kind to be found in defendants' battery?—These instructions direct you toward what you are ultimately to obtain. I think that you do obtain the same effect and the same result in the defendants' battery.

Then do I understand that if I take some carbon and manganese—I will assume for the moment in powder—and make that into a circular shape with the carbon rod in the centre, and wind some blotting paper round it, and put that into a zinc pot, I am taking the plaintiffs' invention?—I never said that. I say that if you have blotting paper which maintains a plastic condition, or is semi-solid as the defendants' paper layer is (it contains some 30 per cent. of water as I have analysed it), and if that is permeated with the exciting agent, plus the hygroscopic—if that constitutes a layer that is in contact with the zinc, and is on the other side in contact with the solid depolariser, which is in a semi-solid condition, and the whole is enclosed, as it is in the defendants' battery, then, in my opinion, you have an equivalent of the plaintiffs' battery, and anyone reading this specification would be led to make it in that way.

I ask you, did I take the invention?—Well, in my opinion, it is the same.

You consider that a piece of blotting paper ——?—It fulfils all the functions *qud* efficiency, and therefore I considered it an equivalent. It is not an ordinary piece of blotting paper which you have got here, you have got a piece of blotting paper so arranged that it does all that this other invention does. It stands up; it is plastic; it is permeated by the excitant; it is permeated by the hygroscopic; it is next to the depolariser; it is next to the zinc; it wants no holding up by canvas bag or springs, or anything round it; it holds itself up, and, in my opinion, it is substantially the same thing.

In your view the question of whether the thing is in a fluid condition to begin with, and is poured into the battery has nothing to do with the battery?—No, I think what you are aiming at here is to give a direction how to make a battery that will act efficiently. I do not think you must lay stress on the actual method of manufacture. That is for a man to vary as he pleases, so long as he arrives at the result that the inventor intends him to arrive at.

I ask you, in your opinion, is pouring and setting any part of this invention so far as the outer layer is concerned?—I say that as regards the actual invention I do not see that pouring or setting is part of the battery described in the invention. As regards convenient directions to arrive at the result the inventor desired, I think it is part of the invention—but only so far as that is concerned.

At this stage the further hearing was again adjourned.

On Wednesday, May 27th, Mr. ALFRED GORDON SALAMAN, further cross-examined by Mr. WALTER, said with reference to the plaintiffs' specification, that in his opinion actual stickiness was not an essential characteristic of either of the layers.

Will you tell my Lord what electrically is the advantage of semi-solidity?—Well, I do not know that one could say electrically.

That is the question I ask. I want to know what electrically is the advantage of semi-solidity?—I would answer it in this way. The advantage to my mind is very great in so far as you have manganese in a semi-solid condition, it implies *ipso facto* that you have fine pulverisation, which means that you have the intimate admixture of the carbon and the manganese peroxide in such a way that as the hydrogen is evolved it will not polarise the conductive carbon, but will immediately decompose the manganese peroxide, and the functions of the depolariser will be uniformly performed throughout the whole mass. That is why I regard it as important from a battery construction point of view.

Will you tell me whether you think I am taking the plaintiffs' invention in substance, if, assuming that I have got the plaintiffs' outer layer, I am only proposing to fill up the inside with a mixture of lead peroxide, sal-ammoniac water, and zinc chloride—will you tell me whether I am taking the plaintiffs' invention if I do that?

His LORDSHIP: The point is no carbon?

Mr. WALTER: No carbon? Is that the plaintiffs' invention?

His LORDSHIP: If you omit the carbon. That is the point of the question, as I understand it.

Mr. WALTER: If I omit carbon am I taking the plaintiffs' invention?—I should say you were taking the plaintiffs' invention, less a very important feature of it—less a very important feature of the combination. I regard this, as I said yesterday, as a combination invention and nothing else, and if you take this carbon away, you take away the conductivity through the depolariser, and that is an extremely important thing.

The witness having been re-examined by Mr. Astbury,

Mr. JOHN REGINALD GALL, examined by Mr. PAGET, said he was in the engineer-in-chief's department of the National Telephone Co., and had been there over 15 years. He was well acquainted with batteries, the company using a large number of batteries. They were used principally for the speaking circuit of the transmitter in subscribers' offices. For that purpose they required a battery that would not polarise quickly, and one that was always ready for use. He had made tests of a large number of batteries. He had tested the Hellesen and the Gassner, and subsequently he tested the plaintiffs' battery, the Burnley battery. As a result of those tests, the National Telephone Co. used the Burnley battery for their work. They used the Burnley known under the name of the E.C.C.

To the exclusion of the Hellesen and Gassner cells?—Practically.

Can you tell his Lordship why the Gassner and Hellesen cells were not preferred, or, rather, why the Burnley battery was preferred; what were the defects of the Hellesen and Gassner cells?—Speaking from memory, I think they would not remain in stock. If you kept them in stock and did not use them, they would deteriorate, and I do not think their recuperative powers were so high as the Burnley.

Was it your experience that the Burnley battery was the best for your purpose?—Yes, of the cells we had tested up to that time.

Do you speak as to the internal construction of these batteries?—No, that does not interest me at all—simply as to their use.

Do you still continue to use the plaintiffs' battery?—Yes, we still use them in large quantities.

You also use the Obach cell?—Yes, in large quantities.

That was the infringement in the last action. At this present moment you are using large numbers of the plaintiffs' cells?—Yes.

Cross-examined: He made the tests about the Gassner and Hellesen prior to 1892. Every dry cell polarised if you kept it on too long, the "E.C.C." or any other battery.

For intermittent work, dry cells were now largely used. The company probably had some of the Obach cells in use at the present time.

Mr. WALTER: There was no injunction granted. The injunction was stayed.

Mr. ASTBURY: Do you say no injunction was granted?—It was granted, but there was a stay.

His LORDSHIP: I suppose the case is going to the House of Lords, and there was a stay meanwhile?

Mr. ASTBURY: Which we consented to.

His LORDSHIP: Mr. Walter's observation only meant that the battery was still on sale?

Mr. WALTER: Still on sale, and has a large sale.

Mr. ASTBURY: Yes, it is a very popular battery.

Cross-examination continued: He could not say when the Obach came on the market. It came to them after the E.C.C. They first used the E.C.C. somewhere about 1892 in large quantities.

Have you noticed the later cells of the E.C.C.? I suppose it is a cell which has gone on improving?—Yes.

It has got better?—Yes, I should say it had. The E.C.C. battery, like all other batteries, was not always up to a high standard of efficiency. The insides of the batteries did not at all interest him.

All you are concerned about is——?—What we get out of them.

I think when they started they used to burst?—We did have a few burst in the first instance. The witness stated that he was acquainted with the old dry batteries. He knew they were in use, but could not say they were in large use.

Mr. Harry Theodore Barnett, examined by Mr. Shaw, said he was a member of the Institution of Electrical Engineers, and was engaged by the Electric Construction Corporation some years ago to introduce the E.C.C. battery to the trade. That was, he thought, in 1890. As soon as he took up the sale of the Burnley battery he was shown a few of the Gassner batteries. He had made some tests of the Gassner in the presence of persons whom he wished to take up the Burnley cell, and in every case it tested so inefficiently that no prolonged test was found necessary. He had tested the Hellesen cell against their cell. Some of his customers took up the sale of the Hellesen at first, but they soon dropped it. That was the date when they were making the Hellesen with colloidal absorbent. His recollection was that the price of the Hellesen wholesale came out at about the same as the E.C.C., but the retail price was actually lower.

With the exception of the Gassner and the Hellesen, did you know any other dry cell in commercial use?—Not until a year after, about.

Did you travel all over the kingdom?—Yes. The witness stated that he travelled about for 18 months to introduce this battery, and in that time the sales had become so large that they could not be dealt with by the Electric Power Storage Co.'s books, which were books dealing with large storage batteries, and he was instrumental in getting the sale of the batteries transferred to the General Electric Co., Ltd. They agreed to take 10,000 a year, and the first year they took more than twice that amount. He had no difficulty in getting orders. The Central Telephone Exchange was one of the first customers, and took up the cells to the exclusion of the ordinary Leclanché. They said the E.C.C. cost them less than the Leclanché did for men's time. The cells were not made with a vent for some time after they were first sold. The cells were very good before the vent was adopted, but there were some bursts.

Cross-examined: He had nothing to do with the manufacture of cells. He could not tell how the cells were made in the factory in those days. The first cells sent out—at least, they were supposed to be—were hermetically sealed up cells, but sometimes they were not. These were sold by the E.P.S. Co. He could not tell how those were made.

If they were hermetically sealed I am a little at a loss to understand why the sea atmosphere did not agree with them. What has the difference of seaside and inland air to do with hermetically sealed cells?—It is very strange, is it not? It has been suggested by an abler man than I that the iodine in the sea atmosphere attacked the zinc on the soldered line by setting up local action.

Witness, further cross-examined, said he had sold some of the cells to Mayfield, in Queen Victoria Street, and he would be surprised to learn that they returned several thousand cells burst. The method of business done by his principals was to give a good discount. He thought the discount in the case of large buyers was 30 per cent., which was usual in the telegraph trade. The cells were used for bells very largely, and for military firing too, and for all purposes where intermittent work was required.

The hearing was again adjourned.

On Thursday, May 28th, Mr. William Phillips Thompson, examined by Mr. Shaw, said he was the chairman of the plaintiff company, and had an intimate knowledge of all the dealings of the company with the Hitchcock patent, which was put before him, in the first instance, with a view to its being taken up in this country. The company had some of the batteries made in order to test them, and they took special care to have the batteries made according to Hitchcock's specification, because they wished to know whether they should buy the patent or not. They weighed the materials according to Hitchcock's prescription. The test which they conducted was a simple one. They had a very strong bell, a large electric bell, and they placed this bell successively on this battery and some other batteries, and one of the batteries they put it on ran for 27 days and nights.

Mr. Justice Buckley: You mean Hitchcock's?—Yes; I do not think any of the other batteries ran more than a day or two without running down.

Mr. Shaw: You mean that this bell was ringing continuously, without intermission, for 27 days and nights?—Yes; it was in a cupboard. I cannot say at night time because I was not there, but we left it ringing when we went away, and it was ringing when we came back.

Did you try a Leclanché battery of the type known in 1890 on the same bell?—Yes; an ordinary common wet Leclanché.

What happened to the Leclanché?—It ran down very quickly indeed, then stopped. Then we let it lie for a minute or two, then it would go on again, but we could never get a continuous current from it.

Mr. Justice Buckley: When you say a very short time, what do you mean?—A few minutes on this bell. It would go on longer with a smaller bell.

Mr. Shaw: Was this a bell which required a large current, or not?—A tolerably large current. It was the largest size ordinary house bell.

Further examined, Witness said they tested the Gassner as well as the Leclanché. The Gassner was tested on a voltmeter, the same as that on which Hitchcock's was tested.

What were the comparative results there?—I remember that the result of the Hitchcock's battery was enormously better than the Gassner, but what the results were I cannot remember.

Examination continued: He was satisfied with the results of the experiments as regarded the efficiency of Hitchcock, and the company bought the patent, and granted licenses to the Electric Construction Corporation to make. Afterwards the license was granted to the Electric Power Storage Co. The two licensees were practically one—one was a branch of the other.

How were you paid by your licensees—how were your profits got?—From the Electric Construction Corporation, Ltd.; we were paid at the rate of 4d. a cell. When the change took place they said that arrangement was very awkward, as they made small cells as well as big, and it would not pay them to make small cells at all at 4d. a cell, so we agreed on 10 per cent. of the actual sales. There was a royalty.

The first year, what did your royalties come to at 4d. a cell?—The Electric Construction Corporation had paid us £600 altogether, they, and possibly part of the time, the other company. I cannot say exactly when the change took place. We got about £600 altogether in the first 12 months.

Further examined, Witness said he estimated that the total number of batteries on which the company had received royalties was about 1,250,000 up to February of last year. In the cells he made, according to Hitchcock, there was no vent put in. The cells worked satisfactorily without a vent, and he had never received any complaint from the licensees of bursting.

In the making of cells with zinc as the outside container was it, or not, a common practice to use amalgamated zinc for making the container?—They always amalgamated afterwards. They made the zinc, and then amalgamated it after it was made.

Is that common with all zinc batteries?—I never heard of it not being done until a day or two ago.

Cross-examined by Mr. Moulton: I should like you very much to produce the bell on which you say this test was made, or one like it?—I will try and get one as near as I can see like it, but after 10 years, and not being an electrician and seeing only the outside of the bell—for I do not think I undid it—it would be rather difficult.

You do not manufacture yourselves for the public?—Never.

Therefore you did not know whether your licensees had returns?—No. Well, they never told me they had. I never heard of them having returns.

When did you first hear of cells being put on the market with binoxide of manganese and carbon, powdered, in the centre with a carbon rod, and some soft layer outside and then zinc?—I never heard of it until after the date of the patent. I cannot say exactly when. Ours was the first I heard of.

After yours, what was the first you heard of?—The first I heard of I think was a thing called the E.S.

What date was that?—I could not tell you exactly, but I think it was towards the end of 1891, or the beginning of 1892.

That battery is well known now?—Yes.

And has been sold ever since 1891?—I do not know that. It has sold, I believe, ever since 1893, but I only found a single specimen in 1891 or 1892.

Then from 1893 on you knew of its being sold?—Yes.

And you brought no action in respect of it?—Yes; I think we commenced an action on one occasion.

At what date?—Any action that we actually commenced was very recent. Since the date of the Siemens's trial.

Did not they bring an action against you because you threatened them?—Not that I know of. They may have done so.

Will you explain why, from 1893 to 1903—10 years—you brought no action?—Because we had an agreement with the E.C.C., or rather the Electric Power Storage Co., that they should fight infringements in given proportions to us, and I never could work the Electric Power Storage Co. up to the scratch of fighting.

Neither you nor your licensees have ever interfered till 1903?—We remonstrated and threatened, and did the best we could.

Did you bring an action in 1903 against those people who were making the batteries?—Yes.

Will you let me see the terms on which you stopped that action. Has the solicitor got them?—I expect he has.

Mr. Moulton: May I have them?

Mr. Astbury: You are absolutely not entitled to see them. It provides for a number of trade matters. I am not going to show these people the terms unless I am forced to.

Mr. Justice Buckley: Disclosure of trade secrets is another matter.

Mr. Moulton: I never disclose secrets, but I want the terms. These terms were made with people who were claiming a right to make the batteries.—They claimed they had some sort of defence, but it was a pretty poor one so far as I could see.

But good enough to settle on?—Settle on when they were willing to pay.

Mr. Astbury said they took a license and paid a royalty. He would not produce the terms, as the matter was quite irrelevant to this action.

Mr. Moulton: Excuse me, it is an issue. This is one of the prior users.

Mr. Justice Buckley: Suppose you get that, it would not be more than this, would it? It would show there was a battery in litigation; that it was worth some one's while to take a sum of money for it. If they had put in a defence, the defence would have been another matter, but a mere compromise does not come to much.

What was the name of the company in 1903 that was making this battery?—I believe it was called the Electric Stores, Ltd.

In 1903 what was it?—I am not sure whether it was Ford, Lloyd and Co., or the Universal Battery Co.

Did you bring an action against Messrs. Clements & Sons?—Not

that I know of. There have been about 60 or 70 actions brought. I have not kept account of them. This was one of them, this Universal Battery Co.

Did you know of any circular letter from the Universal Battery Co. sent all round to their customers stating that they had made these batteries before the date of Hitchcock's patent?—No.

Answering further questions, WITNESS said the Electric Stores cell was the first cell of this type he saw openly sold in the market. The next cell was either the Obach or the I.E.C. There was also the Hale Bros.' battery. Hale Bros. gave a full return of their batteries and paid for them. The I.E.C. were getting theirs from America, and they stopped it for a whole year, and then began again. They were selling them to-day, and he fancied an action had been commenced against them.

Did you not threaten them in 1899 and then not go on?—I do not remember exactly what happened.

I put it to you that they defied you and went on selling?—I will not be quite sure. It is highly probable, because about that time we had the Siemens case in hand.

From 1895 they had been selling openly?—They were not selling openly until after Siemens began to infringe. Then it was hopeless going on any further to attack anybody else.

When you interfered with the International Electric Co., did they remind you of an action which had been brought in the States and was dropped, and did they defy you to go on exactly as before?—One of the companies—I will not be sure it was the International—did mention about the one being dropped in the States. That is the first I heard of that action.

I put it to you they were selling openly all that time?—Not till after Siemens's people began.

Obach and Siemens cells were sold in large numbers in 1894. Who else sold openly?—I do not remember any others at the present time. There may have been others. Since Siemens began infringeing we left off taking any account of these things, because we knew if we did not fight Siemens, the great big man, it was no use fighting the others.

It does not seem to me you had done much before?—Yes, we brought several people to book directly we began. I cannot remember who they were now.

Is there anybody here who is concerned in the manufacture of the E.C.C.?—Not that I know of.

Practically you are the only shareholder in this?—No, there are a lot of other shareholders, but they are all small.

How many shares do you hold?—I tried to buy out the other shareholders as well as I could, and I have bought most of them. I think there are about 500 or 600 shares speaking without the book in other people's hands, the rest are mine.

How many are yours?—4,000 or 5,000.

Have you issued any debentures to yourself?—Yes, £600; and I paid for them in cash.

What was the date of that painful proceeding of paying for them?—I think they were issued during the Siemens trial.

Mr. Astbury having re-examined witness, the plaintiffs' case was closed.

Mr. MOULTON, addressing his Lordship for the defence, said the thing that had impressed him most of all in listening to the evidence in this case was the importance of making up one's mind as to the meaning and scope of the letters patent before one could tell the effect or relevance of evidence. He had heard every witness examined or re-examined as to differences between anticipations and not the total invention, but the particular form of it which appeared in the specification, and which the patentee carefully disclaimed as being the whole of his invention. If his Lordship came to the conclusion that the scope of the plaintiffs' claim was so and so, then an anticipation of any portion of the field that it covered was an anticipation of the invention.

Mr. Justice BUCKLEY: Is that so? As I understand it, the Court of Appeal have held that this is a combination patent. I understand that pulverisation was regarded as essential in the patent and that the patentee claimed pulverisation. Both these claims were sustained in the Court of Appeal, I suppose, the combination patent and the pulverisation of an essential part of the combination. Do you agree that that is the scope of the judgment in the Court of Appeal?

Mr. MOULTON, continuing, said nobody could question that it was a combination, because it was a combination of two layers, but there was no magic in the use of the word "combination." Every arrangement containing more than one element was a combination, and in that sense he did not dispute that it was a combination patent. But the most important thing to consider was that the interpretation of the patent was an interpretation on the evidence just before the Court. Nobody pretended that the interpretation which the Court put upon these letters patent was an interpretation to be obtained from the document itself, without evidence as to the state of knowledge. The consequence was that in this action that interpretation did not bind his Lordship in any way.

Mr. Justice BUCKLEY: On the construction of the document I am bound.

Mr. MOULTON submitted that that was not so on the construction, otherwise than came from the document itself. The interpretation given by two of the learned judges in the Court of Appeal came from the document as interpreted by the evidence of the state of the art, and everything of that kind. Take an example that a hygroscopic body was necessary. Nobody could suggest that that was shown by the document as a piece of construction. If it was going to be said that one could tell from the documents that there must be a hygroscopic in the excitant, one could tell from the document that there must be a sal-ammoniac cell, that must be a question of "what is substantially as herein described," or "substantially" must be a question of the state of the art, and what it would convey to an electrician.

Mr. Justice BUCKLEY: In Hitchcock where he says in describing the inner compound "Sal-ammoniac one part, chloride, or other analogue one-tenth part," you do not say you could vary that so as to omit the hygroscopic altogether?—You must take this or some other one.

Mr. MOULTON: The excitant that he used is sal-ammoniac, and one-tenth part of chloride of zinc or some other chloride, but he may change the whole excitant.

Mr. Justice BUCKLEY: I doubt that.

Mr. MOULTON: Our case will be as plain as possible that this man deliberately says you can change your excitant.

Mr. Justice BUCKLEY: You may vary it.

Mr. MOULTON: But you can change it. Take that very case "sal-ammoniac one part, chloride of zinc or other hygroscopic analogue." It means this, that you can put instead of chloride of zinc, chloride of calcium.

Mr. Justice BUCKLEY: You may put any other hygroscopic and it will work, but you may not omit the hygroscopic altogether.

Mr. MOULTON: The case I am going to put will be that to an electrician this would mean you might change this, and you might have no sal-ammoniac at all. Sal-ammoniac is not part of the patent.

Mr. Justice BUCKLEY: I understand Lord Justice Stirling to say on the question of pulverisation, this patentee has insisted upon pulverisation for this reason: that he says you must get a pasty substance, and you are only getting a pasty substance if your pulverisation is so thorough as that you get capillary attraction. Suppose you prove by evidence that capillary attraction had nothing to do with it at all, then that part of the argument would go, and on further evidence you would be able to show that pulverisation is not insisted upon by reason of the fact that a pasty substance can be reached by the use of the capillary attraction. You can give evidence of that. That would not be contradicted in the construction which the Court of Appeal have put upon the document.

Mr. MOULTON said he would show how the supposed state of electrical knowledge had been used by the Court of Appeal right throughout for the purpose of arriving at what was substance and what was not. All that he was entitled by his evidence in this case to vary. So far as the evidence was varied, the interpretation which his Lordship put upon "substantially as described" would also be varied. That was important, because the history of the last case was extraordinary. The points that were put to the Court as being points of substance were points that were obtained from the witnesses. They were not points upon which he ventured to think there was any evidence which bore on the matter at all. Certainly there was not the evidence that the defendants would bring forward, or the evidence which they had already obtained to show that the points suggested were absurd. He would call his Lordship's attention to one: "Each paste must be independently excited; the one paste must not draw its excitant from the other." That was one of the contentions, and practically a contention which was adopted. To any electrician the idea of saying that that was a matter of substance was ludicrous. This was what it had come to in the last case, and what he trusted they would prevent its coming to in this case—that the invention was defined, not by knowledge, but by ignorance; that points that were never proved with regard to the state of the art had been suggested and accepted, because, he supposed, there was no evidence directly against them. The Courts could not be technical Courts, and if points were going to be put to them that dare not be put to them in the presence of witnesses, it was quite time they should take care that they file the whole of the case, in order that the Court might know by means of oral testimony what the state of the art was. Their Lordships in the previous case had not a great deal of the evidence that he would now put before the Court, and therefore they had to interpret the specification, and, of course, for the purpose of this case he must assume they interpreted it rightly, though which of them interpreted it rightly when there were three distinct interpretations he did not know.

Mr. Justice BUCKLEY: Will you tell me in which way each of them respectively construed it?

Mr. ASTBURY: I think they accepted Mr. Swinburne in the Court of Appeal.

Mr. MOULTON: My Lord, that is really too severe a task for me.

Mr. Justice BUCKLEY: It appears to me they all agreed that it was a combination patent, and that all the several parts were old. They all agreed that there is nothing new in any one of the several parts?

Mr. MOULTON: I think so.

Mr. Justice BUCKLEY: But it was a new combination, they all agreed in that.

Mr. MOULTON: But one thing they did not agree in, so far as I can make out, is this: they did not agree themselves on what it was. That is the real fallacy. Not one of them, unless it is Lord Justice Cozens-Hardy, keeps to the same definition of it. It oscillates between the actual receipt and that which is claimed in the patent, and, so far as I have read their judgments, not one of them does what I am going to ask your Lordship to do: stick to the same meaning of the invention when they are considering the specification and when they are considering the anticipations.

The learned counsel then proceeded to go through the plaintiffs' specification. He would show that to the mind of an electrician—the instructed mind of a person to whom the specification was addressed, for by the House of Lords in the Badische Austin v. Levinstein case it was decided that that was the way you had to interpret it—"Substantially as set forth" would not carry with it what was suggested by the plaintiffs, and would not carry with it

what was taken to be carried with it on the evidence in the last case by the Court of Appeal. He would ask his Lordship to make up his mind as to what from the specification and from the evidence that he would put before him as to the general electrical knowledge was the scope of the patent, and then he would develop the case with regard to that scope. The patent law of England was to take the whole scope of the patent, that was to say, the whole field that the inventor had claimed as his own. If any portion of that was old, the patent was bad until that was disclaimed. When they came to examine the evidence that had been given by the plaintiffs in the present case, he thought he might fairly say that the whole of the distinctions drawn with regard to anticipations were entirely directed to the differences between the whole scope of the patent, and a particular recipe.

Mr. Justice BUCKLEY remarked that what he got out of the judgment of Lord Justice Vaughan-Williams was that the Lord Justice considered that the patentee had insisted upon pulverisation as an essential thing from his point of view, and that the patentee had a valid combination patent.

Mr. MOULTON: Yes, my Lord, I think so, because he took pulverisation to be a novelty.

Mr. Justice BUCKLEY: He says so.

Mr. MOULTON said he would show to his Lordship that pulverisation was not a novelty. It was a question of ordinary electrical choice what condition of pulverisation they should use. He would show that to an electrician's mind the question of more or less pulverisation would be a question of "Do what you like." Ten years before this there had been in standard electrical books estimates of what kind of pulverisation was the best—what was best for the one and what was best for the other—and so far from there being any novelty, it was a thing that had been worked out just in the same way as strains on beams had been worked out. It was perfectly clear that the Lord Justice's mind in deciding with regard to pulverisation was guided very largely by the evidence before him, which was very different to what was now to be placed before the Court.

Mr. Justice BUCKLEY: Lord Justice Stirling arrived to some extent at his conclusion that pulverisation is essential on the footing that unless you have fine pulverisation you will not get the benefit of capillary attraction.

Mr. MOULTON: There again that is absolutely based on evidence.

Mr. Justice BUCKLEY: I agree it is.

Mr. MOULTON: And that I trust we shall change.

Mr. ASTBURY: It is based on one answer of Mr. Swinburne's.

Mr. MOULTON: Your Lordship will hear how we make our battery, and I think you will come to the conclusion that holding up by capillary attraction does not describe ours.

Mr. Justice BUCKLEY remarked that Lord Justice Cozens-Hardy found that there was nothing to indicate that pulverisation, though desirable, was essential.

Mr. MOULTON said that it was very difficult indeed to keep one's ideas clear in the case of a patent where a man had described one thing and broadened it out almost illimitably. It was essential to a right decision to keep one's ideas clear so that you treat as the invention always one and the same thing. They must take one form, which was that which the claim claimed, and compare that rigorously both for anticipation and infringement. He was perfectly certain anticipation after anticipation had been thrown aside because it did not use any flour—because it did not use plaster of paris. His suggestion was that a majority of the learned Judges in the Court above decided that the claim included all cases of two plastic or semi-solid layers, one containing a depolarising material and the other not containing a depolarising material. Unquestionably that was Lord Justice Cozens-Hardy's view. In this case he (the learned counsel) had a great advantage in the question of infringement. The greater part of the argument in the other case, except, perhaps, that which related to pulverisation, was based on the special method of making the outside layer. Defendants' outside layer was made in an entirely different way. What they were using was not a semi-fluid or plastic layer. On the other hand, if it was semi-solid or plastic, then unquestionably plaintiffs' specification had no patentable subject matter at all. Common knowledge however applied could not constitute invention. Whether the batteries were made round, or made square, or made flat, or whether they were made one way or the other in shape was a matter of ordinary common knowledge and common practical choice, and nobody could say that that could even be an element of invention. There were many things which could not constitute an invention because they were so well known to electricians that the whole world was entitled to use them and they must be part of the knowledge of a competent electrician. In the present case the electrical battery considered from the point of view of its electric action was perfectly well known. That was admitted. It was an ordinary Leclanché cell. Leclanché was the first man who saw the advantage of having a carbon electrode surrounded by powdered or crushed binoxide of manganese and carbon, using as an excitant whatever one liked. A vast number of excitants could be used. There was no originality whatever and admitted to be no originality whatever in the electrical combination. His learned friend had tried to suggest that there was a novelty in pulverisation. If there had been no literature on the subject, he (Mr. Moulton) would have thought that it would be impossible to make a novelty out of a suggestion of pulverisation, unless careful and minute directions as to the degree of pulverisation were given. What was the action of the powdered binoxide of manganese and the carbon? The powdered binoxide of manganese stood there ready to depolarise, but as it was a bad conductor they wanted carbon there to conduct the current to the central electrode which carried it off. The hydrogen was developed at the point where it went into the carbon. The consequence was you must have a line of carbon up to the electrode in order that that point may be a point where the current goes in, and there you want your powdered manganese. It was at your choice whether you had it in big blocks, or little blocks. That was a question of experiment for the purpose of finding out what on the whole was best. He was not going to suggest in dealing with this question that this was a claim for the combination with the two layers; but it appeared to him that the effect on the Court of Appeal was very largely due to the idea that this man first thought of pulverisation, and that was stated by the learned judges, or, at all events, by one of them. Leclanché, who had the merit of inventing this, knew perfectly well all about pulverisation. Defendants had put in two specifications which were not before the Court in the last case, in which Leclanché made a dry cell by powdered binoxide of manganese and carbon, holding them in a porous pot, which was the ordinary way in which he used them; and so far as the electrical combination was concerned, that was absolutely the same as in the present case. The porous pot was the way in which he chose to hold them, but the porous pot was nothing in the electrical combination. It gave more or less internal resistance, just as everything that turned fluid into a denser body—that was to say, everything that turned fluid into paste—did. His friend seemed to say: "Oh, it would give internal resistance." So did everything that you used. Everything that you used that was not a pure fluid added internal resistance; but his learned friend could not show for a moment that a porous pot would add more internal resistance than did that by which he made his paste. Nor could his learned friend show for a moment that his combination had less internal resistance than a properly-made combination with a diaphragm—say, a diaphragm produced by a textile fabric. But it did not stop with this description of a dry cell battery by Leclanché in which the materials were pulverised. Fifteen or twenty years ago the whole question of pulverisation had been examined, and the result of those examinations was given in electrical text-books. He had here probably the best known electrical text-book in the world, "Wiedemann's Elektricität," published in 1882.

Mr. ASTBURY: This ought to have been put to our witnesses if my friend wants to refer to it.

(To be continued.)

CORRESPONDENCE.

Foote & Milne v. St. Helens Cable Co., Ltd.

Owing to my absence abroad, I have only recently seen the report of the above case in recent numbers of the ELECTRICAL REVIEW. As certain statements therein are calculated to damage the reputation of my firm if allowed to go uncontradicted, I shall be obliged if you will give me an opportunity through your columns to emphatically deny the statements attributed to Mr. Milne and others that the Simplex system was used for the Mersey Dock and Harbour Board's installation at Stanley Dock, Liverpool.

Before this contract was given out I had an interview with the consulting engineer for the Mersey Dock Board, and submitted samples of conduits and fittings comprising the Simplex steel conduit system, and these were duly approved of by him, and I understood that Simplex material was to be specified for the work.

When calling upon Messrs. Foote & Milne with reference to the matter after they had secured the contract, they mentioned that they could purchase a similar material to Simplex at a lower price, and that they had induced the consulting engineer to sanction the use of this other material, consequently the order was not placed with our firm.

In justice to ourselves, I wish to point out that such remarks in the course of the hearing of this case as "bent ends," "bad fitting tubing," "loose lids to junction boxes," &c., can in no way refer to material supplied by

The Simplex Steel Conduit Co., Ltd.
L. M. WATERHOUSE.

Strand, W.C., *June 3rd*, 1903.

Ourselves in Trouble Again.

I was read your account of the Aldershot Camp, and I, as member of our glorious profession, my responsibility strongly feel to point out that you refer in your article to what you say as to the subject of your remarks. As an engineer born and bred in the world-great-renowned British centre of industrial of Donnerblitzen (Yorkshire), I should if possible know a little something of what I was not talk of. When I tell you yet that the cousin of my wife has a milkman whose name is Smiggs, my Britishness is transcendent. So!

You say in your article that the troubles going out, and

they have to use muscular strength or the assistance of one 10 B.H.P. motor to get them in again. Well, I tell you, sir, when you say that, I tell you and all the world, that is a bad fib, and as an Englishman I am of my fatherland, very much geshamed. And you do not say nothing of my Automatic Brick, for which I was inventor by His Britannic Majesty's Royal Letters Patent, which I would mention there is now valuable opportunity to purchase.

I will say once more, and as a real Englishman again, I think my native land is to the canine dog fast going, and Germany is top, where the native is fondled and the stranger encouraged by my Automatic Brick, of which I will now take opportunity to outpoint its superlative and extreme reality for merits. . . . .

I hope you will excuse my scold you so very, but my British soul rises in arms, as the sayings was, against the ungratefulness and pititude of Albion, and I must say you were worse than my dictionary will let me say, for giving me not a gratis advertisement for nothing, which I am prepared to pay ; and it is great disgrace that educationally-presumed English gentleman of profession cannot write his mother tongue correctly as I have in your "Correspondence" column seen, who say they are true-blue Briton like I, who, card-enclosing, have the honour to remain

Otto Schmidt,
Engineer Lektrik.
Patented No. 54321, 1905.

Soho, *April 1st*, 1903.

Municipal Electricity Undertakings.

I do not often indulge in a newspaper correspondence, but "Consulting Engineer's" reply in your current issue really requires an answer.

The figures, which he quotes for this undertaking for the year ending March, 1901, are, of course, correct ; but it is not correct to insert them in a table, and call them our figures for 1902, which is what "Consulting Engineer" has done in his article. Hence my correction. We are now told they were inserted "in quite a haphazard way," but still one expects articles written for serious consideration to be accurate in figures. I think "Consulting Engineer's" article raises a much more important point, which might be briefly termed "the consulting engineer's responsibility."

Apart from the effect of such articles which Mr. Boot alludes to, how often does one see in undertakings carried out by some of these gentlemen, fearful and wonderful arrangements with a total disregard to the safety of the supply, or the future economical extensions of the system.

Neville Appelbee.

Ashton-under-Lyne,
June 3rd, 1903.

My efforts to persuade "Consulting Engineer," who now signs himself "The Writer of the Article," to disclose his identity have been futile, and therefore I am afraid I cannot continue an argument with an anonymous writer, but I shall welcome a discussion, and be prepared to take part with the writer in question as soon as his name is known.

With regard to the other letter, dealing with the question of "the value of disused cables and tearing up the roads," I would point out to Mr. Mautby Hill, of Brighton, that even when the cables are laid on the solid system, and assuming that they are broken down, obsolete, and require renewing, as suggested by "Consulting Engineer" (after 11 years' working) it will be necessary to re-open the roads to put down a *new* cable to take the *old* one's place, and naturally any sane man would lay the new cable in the same trench as that occupied by the old, so that "The tearing up of roads, and the making good again" as suggested by Mr. Mautby Hill, would be done for the laying of the new cable, and not for taking up the *old* one, unless the undertaking gave up the supply of electricity by means of underground cables.

He is kind enough to ask me to enlighten him with respect to the "Brighton depreciation fund," but, as a professional man, I should naturally be pleased to undertake the work for the usual consulting engineer's fees, and, upon receipt of his commands, they will have my careful attention.

It may interest your readers to know that there have recently been great improvements in single-phase motors, and now it is possible to obtain one that only takes one-fifth of the full-load current to run into step, or with the full-load current, the speeding-up torque is equivalent to $1\frac{1}{4}$ times the full-load torque.

Horace Boot,
Consulting and Resident Engineer.

Tunbridge Wells,
June 6th, 1903.

Free Trade or ——?

Anyone reading the article, "Free Trade or ——?" in your last week's issue, will come to the conclusion that the writer of it has the "Protection" bee in his bonnet badly, at any rate so far as German goods are concerned, and this can be the only sane explanation of his endeavour to make statements which he could not substantiate.

I trust that these few remarks will enable your readers to properly discount the statements made in the article, and I will therefore not do the writer the honour of treating him seriously and refuting them.

Undeluded.

The Value of Units Not Metered.

"Author," in his contribution of the 5th inst. to your esteemed journal, opens his lecture to the station engineers of this country by calling their attention to the points in meter testing, which he assumes they have overlooked, and concludes with an earnest exhortation to mend their ways and make "a wise choice of meters."

In doing this he appears to be deplorably ignorant of the very stringent tests through which meters have to pass in most stations, as well as of the fact that the test on short circuit is a very general one.

As a matter of fact, there exists at least one type of mercury bath meter whose accuracy, say, for a $2\frac{1}{2}$-ampere meter, is wholly unaffected by passing 10 amperes, or even more, through it ; and this being the case, his instructions to the buyer as to the sizes he ought to order seem somewhat superfluous.

Surely in issuing his tables he is not aware that there exists such a body as the London County Council, who seal meters mainly of the mercury-bath type under very stringent conditions ; but he ought to know that the confirmation of such figures as he instances, repeated on the Kelvin balances, or potentiometers, of most stations, would entail their immediate return to the manufacturers.

Yet, although he apparently disparages existing tests, he is forced to acknowledge one patent truth, viz., "probably motor-meters of the mercury-bath type are more generally used in England than any other type," and this admission amounts to a recognition of Darwin's law of the survival of the fittest, and ought to furnish some practical recompense to the manufacturers of such types.

Many station engineers can reply with much greater force to "Author's" letter than we can, but as it seems improbable that any station would furnish its results to a manufacturer for the purpose of an attack upon a competing manufacturer, we can only suppose that "Author" has bought the meters he criticises second-hand, and is either to be welcomed as an inventor of some irreproachable type or as a scientific Daniel.

Venner & Co.

Shunt Losses in Meters.

The writer of the letter which was published in your issue of June 5th, claimed a starting current of $\frac{1}{10}$th of the full load for some types of shunt meters on the English market ; the claim is too modest. The writer of this letter has in mind a consignment of six meters recently received, three of which register continually when connected on the supply side, without the necessity of connecting anything on or to the consumers' terminals ; the other three show a

decided objection to stopping, having been once started by passing current through them. Doubtless, if they are put in use so that the commutators have a chance to get dirty, they will more than compensate for this excellence by registering a more than corresponding amount too little; by some such means assuredly approximate justice achieves its ends.

T. Dawson Clothier.

Bootle, *June 5th*, 1903.

A "Shocking" Leak.

In your correspondence of the 22nd and 29th ult., I notice some accounts of electricity on steam pipes. May I give you two accounts of the same that I have experienced? The first one was a steam joint that was blowing one dark night. It was a 20-in. pipe, and the steam was blowing for about 2 in. of the joint (steam pressure 120 lbs.); the luminous effect of that lit the joint and pipe up for some distance about it, and the light could be seen some considerable distance off. But, strange to say, I felt all over the pipe and could not get a shock from anywhere.

Case No. 2 is of a quite different order. It occurred under a winding engine house at a colliery. One of the engine men (the night man) had occasion to oil his engines just before leaving work, and having occasion to pick the oil can up (which was kept against the steam chest of the engines) received a nasty shock in doing so; not to be beat, he took his cap to pick it up, and received a shock through it. I may also state that if the oil can was anything like an inch from the engine steam chest, you could get intermittent sparks from the oil can to steam chest. There is a pair of engines coupled up together, and yet I could only find traces of electricity on the steam chest of one engine, and the bright work and lubricators of the same engine. I think the reason of it being so strong on the oil can was that it must have been acting as a condenser.

I should like to have other views on the matter.

J. C. Dodd.

Wigan, *June 4th*, 1903.

Chicago Slabs.—A correspondent asks:—"Where can we buy Chicago slabs for commutators?" We believe it is a lubricator of the nature of plumbago and tallow." Can any reader help the inquirer?

To "F. A. W."—The Blackpool conduit line was opened in October, 1884. The Walsall—Wednesbury overhead trolley system was inaugurated on December 31st, 1892.

PROTECTION FOR ELECTRICAL INDUSTRIES.

By G. BYNG.

Having been asked by the Editors of the Electrical Review to give my opinions on the subject of Protection as applied to the Electrical Industries of Great Britain, I will endeavour to show my fellow electricians (or, at least, such as are not yet of my way of thinking) in a few words how their future prosperity, and therefore that of our country, is wrapped up in this great and necessary change.

By way of parenthesis I wish to make a few remarks of a personal character. For many years this great subject has given me much food for thought, and during that time I gradually accumulated and formulated ideas and arguments based on actual facts and experiences, and with a full knowledge of all the standard Free Trade writings and arguments—Protectionist books there were none. Therefore, when in 1901 I published a book advocating a change from what had become a shibboleth, such rank heresy came as a thunder-clap to many who were invited to review the book. One electrical journal sent me an intimation to the effect that they were horrified at the mere mention of the word "Protection," and really, although they had every respect for the author, they could not think that any man in his senses could venture to . . . in fact it was really quite impossible for them to read the book or to review it. The editors of the Electrical Review were, however, kind enough to devote some considerable space to a review of the book, and even credited the author with some sense; but they also appeared to think that he must have a screw loose for criticising such a revered subject at all. In view of these opinions I may, perhaps, be excused from quoting the following passages from my book, written in the early days of 1901:—

> Suppose a serious agitation were to begin soon, I believe the hands of the Government could be forced within 12 months, and we should have a general election purely on the question of Protection or Free Trade. In such a case we might have Protection established within three years.
>
> To attain this would be a splendid achievement, for in the saving of seven or eight years out of the ten which I allot as the period necessary for Free Trade to die a natural death, the nation would benefit to the extent of about *five hundred million pounds sterling*. (Page 236.)
>
> The public must be taught that an Empire, like a business, cannot be carried on unless it pays at least its own expenses. But who of all our statesmen has the acumen or the courage to tell people the truth?
>
> We naturally turn towards our Secretary for the Colonies. Mr. Chamberlain was some 20 years ago himself engaged in large industrial enterprises, and it is impossible that he should imagine that the position of the English manufacturer is the same to-day as it was then. It is entirely changed. In those days the effects of Free Trade were harmless; as harmless as dynamite shells without their fuses. Since then Free Traders have themselves taught the enemy how to prepare and apply the fuses. At that period our manufacturers and traders reaped material benefit from the relations which then existed between the Mother Country and our vast over-sea Empire. But to-day the case is reversed. Our present Colonial policy is actually doing grievous harm to our industrial classes, because foreign manufacturers are gradually annexing the trade with our possessions, paying nothing for the privilege, and being, in addition, subsidised and supported in every way by their own Governments. Our rivals thus are not handicapped as are we, and if the present system remain unchecked, they will win all the races over our own courses. (Page 214.)

Mr. Chamberlain *has* come to the rescue; the country is veering round, and the truth is prevailing. If, therefore, I see my pioneer work being acknowledged, I may be allowed the pleasure, *en passant*, of rubbing it in to my friend the enemy; and in returning to that particular phase of the question which is indicated by the title, I would like to add that if anyone wishes to study the whole question of Protection, I can refer them to my book and to the various articles which I have written in the reviews, as, for instance, in the *National Review* for June.

Apologising for this digression, I will now address myself to my fellow electricians, and I will confine myself to elaborating arguments based on their probable answers to the following question:—*Are you satisfied with the present state of the electrical enterprises in this country?* I think I can readily supply the answer, which will vary according to the various classes engaged in electrical work at the present moment. Of such classes there are four, viz.:—

1. *Manufacturers* (both masters and men).—This class cannot possibly be satisfied to see £1,000,000 worth of foreign electrical goods coming into this country annually.

2. *Contractors* (both masters and men).—Although this class buys in the cheapest market, the goods only remain cheap so long as the foreigner meets competition. When he has killed this, he puts up his price. The contractor only does what he is obliged to do in order to live, but he cannot be pleased to have to spend his money out of the country.

3. *Purveyors of Electricity* (supply authorities, G.P.O., telephone companies, &c.).—The above remarks also apply in this case; the purveyor must also know that by spending large sums in foreign countries he reduces the welfare of this country, on which his own profits depend.

4. *Factors* (representing foreign manufacturers).—This category cannot but be delighted at the present state of things, by which they keep themselves and the foreign manufacturers going, at the expense of the nation. They are only concerned to send as much money as possible out of the country.

I therefore take it that, with the exception of the last class, my fellow electricians are not satisfied with the present state of things, even if they are not all as personally (and directly) affected as the manufacturer.

What is the reason of the failure of this country to hold its own? Many people are ready to give reasons. For instance, my friend, Mr. Madgen, will say that it is muni-

cipal trading; others will speak of vested rights, finance, patent laws, education. All these factors I have carefully studied, and as regards the last let me again quote from my book:—

The cry for Education, primary, commercial and technical, has been loud during the past 10 years. It is claimed that if only we could educate our people as well as some other nations teach theirs, our industrial superiority would again become supreme. It is not necessary for me to dwell on this statement at any length here, but I must draw the Free Trader's attention to the fact that the education cry is another proof of my contention that the followers of Cobden consider the Englishman less qualified and less skilful than the citizens of other nations. In pursuance of this belief, they call for education, wherein they are wrong. *They mistake the effect for the cause.* Their education will be at best a palliative. It will not serve as a remedy.

Our *Electrical Engineering Industry* affords a striking example of how our ill-success in competing with other nations must be due to causes apart from the want of technical education.

Early in the eighties the invention of the dynamo, carbon lamps, accumulators, motors, &c., started the electric light and power industries. England was then far ahead of other countries in opportunities for teaching the young electrical students. We possessed practically the monopoly of telegraph and submarine cable factories, and their costly laboratories were the nurseries for electrical teachers and inventors. Our literature on the subject was the main source from which others drew their theoretical knowledge, and there was no lack of electro-technical colleges, well equipped, and conducted by efficient teachers.

The result was that in those days we led the way in electrical progress. Electric lighting of private houses, ships, and also central stations originated in this country. The improvements in dynamo winding, making of incandescent lamps, accumulators and transformers were English. The first electrical tramway and electrical boat were made in England, and there is no doubt but that at the start we were ahead both technically and commercially.

Yet to-day we are far behind other countries, and we are even compelled to obtain abroad the equipment of our biggest electrical undertakings, such as central stations and tramways.

What is the reason? This question has been asked over and over again by our daily and our technical press. And of course all sorts of explanations are forthcoming. The Electric Lighting Acts and other legislation, vested rights and similar obstructions, losses incurred through swindling company promoters, and last and not least, want of technical education. I am convinced that none of these are true causes—the real ones are the discouragement resulting from our Free Trade policy and the obstructive tendencies of our patent laws.

I can prove my assertion up to the hilt, but it would lead me too far to go into the necessary detail. Suffice it to say that the period of retrogression as compared with the work of foreign electrical manufacturers, commenced as soon as those manufacturers, supported by protection and our orders, were ready to compete against us in our own markets.

And this fact is beyond dispute! In this great and important industry England possessed all the advantages of scientific knowledge, of experience, and thorough technical education—yet in practical results we are beaten by competitors.

I need hardly assure my readers that I am an ardent advocate of technical education, and my views on this subject make me the more desirous to impress upon my readers that we can never hope to reap the full benefit from it until we are in a position to provide adequate inducements to attract students.

The same may be said of other so-called causes; collectively they no doubt have a great deal to do with the present stagnation, but they are only secondary *effects* of the working of our fiscal system. The real *cause* is Free Trade. Let me appeal to engineers, as business-men, on one issue only, in order to drive my argument against Free Trade home, namely,

Cost of Production.

I will prove that under our present system we are condemned to produce at a dearer rate than electrical manufacturers in a protected country. The few exceptions do not affect the main issues. This dearness has been patent to all of us; otherwise why should we spend £1,000,000 annually abroad? Yet many have tried to account for it in other ways. They cry: "Higher wages." Had they really troubled themselves to go into the question of wages in England, Germany and America, they would know that, if anything, wages (and salaries also) are higher abroad.

But the very foundation-stone of Free Trade is cheapness. Free traders have always cried, and are now crying: "Let us get our supplies and food for the workmen in the cheapest market (never mind what happens to our home producers). This will give us cheap wages, and we will beat the world!" What does Farrer say?

"A free country has such advantages in production that it can compete with a Protectionist country, even in the home market of the latter. There are many free and neutral markets, and in all of them a Free Trade country has advantages over a Protectionist rival."

What a travesty of the truth, as gained by actual experience! This fundamental theory, on which the whole of Free Trade stands, is not only fallacious, but exactly the opposite has occurred. *The cost of production is higher* in a Free Trade country than in a Protectionist country. How can anyone who understands this remain a Free Trader? Although I hold that Free Trade has no advantage whatever, yet, even if it had all the merits which its advocates claim, this one fact will outweigh all.

—Therefore, I say, a nation that cannot produce as well or as cheaply (the terms are synonymous) as any other must eventually be ruined, just as a manufacturer who cannot compete with his neighbours goes to the wall. Let there be no mistake about this; it is a law of economics as sure and as certain as the laws of nature. It behoves us, therefore, to do all that we can to put our house in order.

Now I will prove how it is that we cannot produce as cheaply in this country as abroad. My fellow electricians know that modern manufacture is based not on the question of wages, but upon the enterprise of the master. What does enterprise mean? It means large works, new and good machinery, skilled supervision, up-to-date methods, and so on. But how can a manufacturer be enterprising unless he has a free market to sell his goods in? We have none; the German, or American, or Frenchman has his own protected market to sell in—and ours. He has only to undersell us in order to kill our competition, when he at once puts up his price. How can he afford to undersell us? I will show. With the knowledge that he has two markets to sell in, he has the enterprise and the confidence to build large works; *he makes larger quantities of goods than we do*, for disposal in his own country and in ours. As price is regulated by quantity, he can make more cheaply than we can, besides having better machinery to do it with.

What, then, does he do? Finding competition in this country and fearing only home competition in his own, he dumps his *surplus* output into England at a ridiculously low price, making his own countrymen pay for any possible loss. Mr. Chamberlain stated in his speech in the House of Commons that a man making £50,000 worth of goods and earning £5,000 profit could, by doubling the quantity of articles to £100,000 worth, earn £15,000 profit. This shows that quantity determines price, and confirms what I wrote two years ago. Let me again quote from my book:—

The basis of the theory of cheapness of manufacture is the following idea, often stated by Free Traders: *the cost of production of a manufactured article depends on three factors*:—(1) *the cost of the material*; (2) *the cost of the labour*; (3) *expenses*.

This may have been to some extent true 60 years ago, but it is not true to-day, as every manufacturer knows, because this reasoning leaves out one consideration which we may call the independent factor—The Quantity produced.

And in most cases this factor influences the cost of labour and expenses to such an extent that it entirely overshadows both. It is due to the application of power, and the enormous improvements in machinery compared with the mode of manufacture employed half a century ago, which depended mainly on manual labour.

With few exceptions this applies to every manufactured article of the present day. Whether it be an article produced for 1d. or for £1,000, whether it is a screw or a watch, a piece of machinery, a piece of cloth, or a locomotive. This principle holds good to-day in every branch of manufacture.

How, then, I ask, can the English manufacturer have enterprise? What power has he to produce cheaply? Let me take only two cases—viz., dynamos and telephones. Which of us does not know to his cost how the foreigner competes in dynamos, and how his agencies are planted in this country? Have any of our manufacturers established agencies in foreign countries? We have all heard of the depression in the German electrical industries through reasons quite foreign to the question at issue. But this did not prevent the Germans from doing a roaring trade in this country, in taking orders at ridiculous prices, and thereby keeping their works going. In fact, so free is our market that we tide the German manufacturers over their difficulties by withholding orders from our own manufacturers.

Again, to take the question of telephones. The German and Swedish makers are able to flood this country with their manufactures, made in much larger quantities than we can turn them out under our one-market system, although these

instruments are not one whit better than, or as good, in construction, as, those of British manufacture.

But the question of costs and quantities is not the only one involved. Free Trade stifles invention and new industries, which are both factors of enterprise; Free Trade drives skill and originality to other shores; Free Trade leaves us intellectually, physically, socially and morally lower than our neighbours, because it deprives us of the ambition to develop our own estate. As an English manufacturer, I say that there is not a single electrical article which I will not produce as well, as cheaply, and as quickly as any foreign manufacturer, if I receive the same help and protection as are enjoyed by the foreigner. But I cannot be expected to risk my money when I am heavily handicapped by not having a secure home market. Personally, I have attempted, perhaps more than any other manufacturer, to make new articles; sheer hard work has made me lucky with some, but all such ventures have brought home to me the injustice of our fiscal system.

At length there seems to be some chance of a remedy; amid the shrieks of politicians and newspaper men, Mr. Chamberlain has had the courage to take the lead. But amongst all these outcries, the voice of the producer, and of the thinking workman, have not yet been heard. As a manufacturer I emphatically endorse Mr. Chamberlain's promise of higher wages for working men in an era of protection; indeed, so convinced am I of the truth of this, that I am prepared to give an undertaking to pay higher wages as soon as this country protects me against the foreigner. The future of the country, its maintainence and integrity, must depend on the producer, and almost entirely concerns him. We in the electrical profession and trade are bent upon increasing our businesses, and this great question of the future of the nation is equally our future. I therefore appeal to my fellow electricians not to be silent, or to leave off working until the great consummation has been achieved, which shall put us as a nation into the same position as that held by other countries—a position which we were persuaded to throw over 50 years ago by the clamour of a few men.

I cannot conclude in a better way than by quoting a Free Trade historian—A. Mongredien :—

> So absolute and so sudden a reversal of the policy by which the commercial destinies of an empire had till then been guided was unprecedented. The new policy thus boldly inaugurated was untried. It was utterly condemned, strenuously opposed, and its failure confidently predicted by a numerous body of influential men. It had its foundation not in experience, for it was an innovation; not in example, for no other country had tried it; but in the theories of thinking men who elaborated the system in their closets."—*A. Mongredien. "Free Trade Movement in England. Issued by the Cobden Club.*

And it has remained nothing more than a theory.

THE MIGHTY ATOM.

The special meeting of the Physical Society at University College, London, June 5th, 1903, was one of the most successful that the Society has held; we venture to hope that this success will encourage the Society to extend its activities in a more generous orbit, and to restrict itself less to its classic but inhospitable and inconvenient quarters at Burlington House. The following report is unofficial, the meetings being now open to the Press—a permission of which we took advantage.

Prof. Rutherford began by describing some of the radio-active properties of such substances as uranium, thorium, radium and polonium, pointing out that, although these substances differed widely in activity, their behaviour was, in effect, somewhat similar, especially in the case of radium and thorium; uranium differs slightly from these.

Close observation shows three types of these radiations, distinguished as α, β, and γ rays. The α rays are projected bodies, very easily absorbed by thin layers of matter; they are "a flight of material particles," charged positively, and they have a mass which is of about the same order as that of the primary atom, *i.e.*, the ratio of the charge of the carrier to its mass is $\frac{e}{m} = 6 \times 10^3$. These α rays give rise to the greater portion of the ionisation of a gas, increasing its conductivity. Their velocity is very great indeed, being about $2{\cdot}5 \times 10^9$ centimetres per second. They have the same size as the hydrogen atom, and a velocity of about one-tenth that of light. They are deviated by a strong magnetic or electric field, the direction of deviation being opposite to that of cathode rays. They carry with them a very large amount of energy; it is of the order 10^{-5} ergs for each such particle. Each individual α ray has enough energy associated with it to excite phosphorescence visible to the eye. A thickness of aluminium 0·0005 cm. can be traversed by the α rays before their intensity is reduced to one-half.

The β rays are similar in all respects to cathode rays produced in a vacuum tube. They consist of negatively charged particles, projected with greater velocity than cathode rays. This velocity lies between 2×10^{10} and 3×10^{10}. They are extremely penetrative; they will pass through thicker bodies than those which are opaque to cathode rays from an ordinary vacuum tube. These β rays can traverse 0·05 cm. of aluminium before their intensity is halved.

The third class, γ rays, seem to resemble X rays. They are not deviated by a magnetic field, but they are extremely penetrative. A thickness of 8 cms. of aluminium is necessary to reduce their intensity to half value. They may be a wave motion. Of the whole sheaf of rays the most important as conveying the most energy is class α. The γ rays are possibly an attendant consequence of the β rays, and are not fundamentally important.

Apart from these rays, the radio-active substances give off something else. For example, thorium oxide and certain other thorium compounds, though they may afford no trace of α and β rays, emit something which may be termed the thorium emanation. This emanation is akin to matter in the gaseous state; it is minute matter, and can be carried in a stream of air through a tube or otherwise. Radium exhibits emanations similar to those of thorium, and its effects are more persistent. The emanations behave like radio-active gases. Their rate of diffusion can be measured, and they can be occluded in radio-active bodies. Prof. Rutherford showed that they could also be condensed by liquid air. A slow stream of air from an ordinary aspirator was passed through a tube containing thorium oxide, and then along a length of "compo" tube of several metres to an electroscope, which was almost immediately discharged. A coil of lead tubing was then immersed in a Dewar vacuum jacket surrounded by liquid air and connected to the stream-tube. The escaping air (temp. $-120°$ to $-150°$ C.) was now unable to discharge the gold leaves. With radium this condensation occurs at $-150°$ C. The effect is not due to ionisation. The emanation from radium differs from that of thorium in the rate of its decay. The emanations themselves are able to excite radio-activity in all bodies near to them; and this excited activity likewise decays in a definite manner. They behave like radio-active gases, for they diffuse like ordinary gases, and the rate of diffusion can be measured. It would appear that they have the properties of a gas corresponding to a molecular weight of about 100. Curiously enough, the emanations themselves seem to be absolutely inert in respect to chemical action. They thus differ from the radio-activity they excite, for this is affected by subsequent chemical treatment. They can be neither seen nor weighed. It is characteristic of the emanations and the excited activity that the process of decay is the same under all conditions.

The emanations, apparently, cannot be affected by any chemical treatment, however drastic. The excited activity, on the other hand, is able to be affected by certain chemical means. The amount of matter involved in these emanations is inconceivably small. It would probably take many hundreds of years, or thousands of years, to collect enough to measure by a balance. But the methods of electrical and magnetic measurement are so extremely delicate that it becomes possible to detect and measure the quantities. Thorium and radium emanations, and the excited activities they produce, are but examples of a very large number of similar phenomena which the radio-active bodies exhibit. The radio-activity of radium is definite and constant. It is possible, however, that the radio-activity of uranium may not be due to uranium but to something else. By a single chemical process it is possible temporarily to remove

the whole of the active constituent, uranium X, from uranium. Similarly, by a chemical method, Prof. Rutherford and Mr. Soddy have found that the radio-active constituent, thorium X, can be separated from thorium. By some subtle process, however, the uranium X and the thorium X both lose their activity after a time, whereas uranium and thorium, from which it has been robbed by chemical means, regain it. Prof. Rutherford suggests that in some way the matter in radio-active bodies is undergoing change, by means of which new substances are being produced which are temporarily active, and that, on the average, these substances decay with time. The curve of recovery of intensity of the mother substance is then shown to be complementary to the curve of decay of the radio-active emission. Thus, if for the curve of decay,

$$\frac{I}{I_0} = e^{-\lambda t}$$

the curve of recovery is represented by

$$\frac{I_t}{I} = 1 - e^{-\lambda t}.$$

The amount of activity lost, due to two or three days' submersion of the substance in ammonia, could be detected. If water is added to the radium so as to dissolve it, the emanation has a better chance of getting away, and is, under these conditions, more easily carried over by a current of air than when the radium is dry.

Radiation implies change. This thorium X is a body from which something has been expelled. There appears to be a close connection between radiations and chemical change. The thorium X atom is, similarly, radiant matter: it throws off positively charged particles. The process continues, each change being determined as to its magnitude by the activity of the preceding stage. First are thrown off positive bodies, these are the most important in the energy problem; they are followed by negative electrons and cathode rays. The α rays are very readily absorbed. They are projected forth, and bring about ionisation of the gas surrounding the active substance by their collision with gas molecules. When these gas molecules have absorbed the rays, the radium is subjected to self-bombardment; consequently it grows hot and maintains its temperature above that of its surroundings, as observed by Curie. The amount of energy given out is enormous in proportion to the size of the projectiles. It is calculated that a gramme of radium contains enough energy to raise 500 tons a mile high—*i.e.*, about 10^9 gramme calories—the energy required to raise one ton one mile being about 2×10^6 gramme calories. Of matter in general, we have no evidence of the amount of heat in an atom; we know nothing about the energy of the atoms. There is no reason why there should not be an enormous store of energy in matter itself, of which we get evidence only in radio-active processes.

In congratulating Prof. Rutherford and Mr. Soddy upon the research which has opened out to them, Sir Oliver Lodge said "it seems a good time in Physics." Prof. Rutherford's discovery of the fact that atoms of matter were pitched out into space at a rate of one-tenth the speed of light, must account for some energy effects, as, for instance, the observed effects in respect to heat. If the energy is passing from the atomic to the molecular form, from a form unknown and atomic, into a molecular form, we ought to be prepared to find heat. The really important thing was that great paper of Prof. Rutherford's in the February *Phil. Mag.*, in which was established for the first time the emission of atoms of matter moving with a velocity comparable with that of light, and the determination of their weight. If they turned out to be helium it would be very interesting; the vital thing is that they are *matter*. Here was the evolution of matter going on before our eyes: a thing which had been dimly suspected by Crookes, Lockyer and others. It may be that this hypothesis of the degradation of the atom, that is to say, of the transition from one form of matter to another, and the assumption of the instability of matter is of the nature of speculation. There is great need for confirmatory experiments in regard to these recent observations. If it is a speculation, it is a most reasonable one, and very suggestive. Rapid inter-atomic movements, electrons revolving round an atom of matter as in the Zeeman effect, necessarily give rise to radiation and loss of energy. Instability of the atom ought to result. It is known that when an electric charge oscillates, there is radiation. And it is known that when an electric charge revolves, it must radiate, because the rotation can be resolved into two simple harmonic constituents. It is known that whenever an electric charge turns a corner, it must radiate, and the radiating power of an accelerated change has been calculated by Larmor, and accepted by J. J. Thomson and others. The energy emitted per second is—

$$= \frac{2}{3}\frac{\mu e^2}{v} \dot{u}^2,$$

where v is the velocity of light, and $\dot{u}$ is the centrifugal acceleration. Now if a charge is moving in an orbit of radius r, the expression for the acceleration is—

$$\dot{u} = \frac{u^2}{r}.$$

If it is moving in an orbit controlled by electrical forces such as a charged body moving round another more massive body charged equally and oppositely in an orbit of radius r, we may equate the centrifugal force to the attraction, and so we have—

$$\frac{m u^2}{r} = \frac{e^2}{k r^2},$$

which gives us a sort of Kepler's law $r u^2 = const.$

The actual motion may be much more complicated, but this, at any rate, is a first approximation. From these three equations we obtain an expression for the radiating power—

$$= \frac{2 u^8}{3 \mu \left(\frac{e}{m}\right) v^5}.$$

This is an interesting expression for the energy lost per second. First of all, everything is constant, except v. We observe that the radiating power is proportional to the eighth power of this velocity, which suggests Stephan's law in ordinary molecular motions—*i.e.*, that radiation varies as the fourth power of the temperature. The temperature is measured by the square of the molecular velocity, hence the radiation varies as the eighth power of the velocity in those heat motions as it does here in inter-atomic motions.

If the revolving thing radiates, that will be equivalent to a resistance; it will lose energy by the radiation as if it were moving in a frictional medium. The effect is to hurry up the moving body, drawing it nearer. It moves more quickly. The radiation tends to hurry it up, and this again increases the radiation. If the velocity increases tenfold, the radiation increases a hundred million-fold. Ultimately, some of the revolving particles will reach the speed of light and then something must fly away, with re-arrangement of the rest of the atom. The speed with which they go must represent their orbital motion. It is not unlike the formation of an earth and moon system. This would seem to apply to every atom of matter, and not only to these heavy atoms, though these are less stable. Every atom contains within itself some seeds of decay; we ought not to assume that any atom is eternally permanent. It seems as if we should find a rise and decay in ordinary matter, as if we could write a kind of history of any given piece of matter, and find it ultimately dying down, perhaps into electrons: somewhat as a nebula contracts and collapses into planets, and into a central radio-active sun. By some such process it may be surmised that there have been generated the chemical elements that we know.

Southport Tramways.—The accounts for the past year show a deficit of £1,222 compared with a profit of £40 in the preceding year. The total borrowing powers of the committee amount to £175,000, and of this sum £103,500 has actually been borrowed. The total distance of the track in the borough is 19 miles 1,294 yds., and of this length 10 miles 1,294 yds. is leased to the Tramways Co. The traffic revenue for the year has amounted to £16,179, the total revenue being £16,387. The working expenses have been £11,221. £3,493 has been devoted to paying interest on capital, and £2,884 to the sinking fund. The passengers carried numbered 3,535,434, and the average total revenue per car-mile was 9·401d. The shrinkage in the receipts is attributed to the cold summer. There are now 26 cars available, 17 double-deck, eight Californian, and one single-deck closed car.

BUSINESS NOTES.

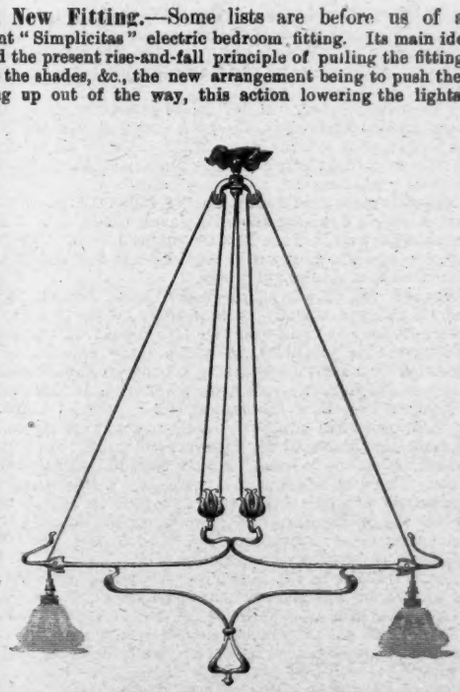
Electrical Wares Exported.

Week ending June 10th, 1902.		Week ending June 9th, 1903.	
Amsterdam	Value £175	Adelaide	Value £51
Auckland	621	Aden	92
Bangkok	134	Alexandria. Elec. fuses	140
Barcelona	91	Amsterdam	17
Boca. Teleg. poles	82	Auckland	325
Bombay	247	,, Teleph. mat.	2,040
Brisbane	53	Bangkok	126
Buenos Ayres. Teleg. mat.	347	Bluff	108
Calcutta	616	Bombay	
,, Teleg. cable	809	,, Teleg. mat.	41
Cape Town	86	Buenos Ayres. Teleph. cable	285
Channel Islands	150	Calcutta	284
Coatzacoalcos	13	,, Teleg. mat.	1,005
Colombo	119	Cape Town	20
Copenhagen. Teleg. wire	63	Colombo	226
Durban	931	Copenhagen	48
East London	441	Delagoa Bay	67
Fremantle	747	Durban	888
,, Teleg. mat.	143	East London	12
Liban	112	Fremantle	147
Melbourne	170	Hamburg. Teleg. mat.	130
,, Teleg. wire	1,845	Kobe	219
Perth	1,276	Lisbon	45
Port Elizabeth	402	,, Elec. cable	350
Rangoon. Teleg. cable	245	Malta	18
Rotterdam	100	Mauritius. Teleg. mat.	546
St. Petersburg	950	Melbourne	101
,, Teleg. mat.	79	New York	12
Santa Cruz	41	Perth	1,051
Santos	42	Port Elizabeth	460
,, Teleg. mat.	96	Quebec	70
Shanghai	172	Rangoon	9
Sydney	395	Rio Janeiro	26
Teneriffe	60	,, Teleg. cable	715
Trieste	127	Santos	80
Wellington	270	Shanghai	82
Yokohama	27	Singapore	1,464
Zanzibar	24	Stockholm. Teleg. wire	44
		Sydney	174
		Tientsin. Teleg. mat.	313
		Wellington. Teleg. mat.	85
		Yokohama	398
Total	£11,062	Total	£11,684

Foreign Goods Transhipped.

Channel Islands. Elec. cable	Value £105
Sydney. Elec. lamps	75
Total	£180
Sydney. Elec. lamps	Value £50

A New Fitting.—Some lists are before us of a new patent "Simplicitas" electric bedroom fitting. Its main idea is to avoid the present rise-and-fall principle of pulling the fitting down with the shades, &c., the new arrangement being to push the actual fitting up out of the way, this action lowering the lights to the position in which they are required; the use of balance weights with lead shot, which possess an element of danger, is entirely dispensed with. A further feature is that by pushing the fitting up, say 6 in., the lamps descend 12 in., so that the ornamental fitting can be retained in the best position, while the lights can be raised or lowered over a good distance. The idea can be very easily comprehended from a glance at the accompanying illustration. The fittings can be obtained from any of the wholesale trade houses.



A New Electric Fitting.

Natal.—The value of the electrical materials imported into Natal during the three months ending at March last is returned at £21,000, as compared with only £12,000 in the first three months of 1902.

Bankruptcy Proceedings.—A sitting of the London Bankruptcy Court was held on Tuesday, before Mr. Registrar Linklater, for the public examination of Harry South, electrical engineer, 43, Rathbone Place, Oxford Street, and late of 10—12, Garrick Street, Covent Garden. The debtor commenced business in 1884 or 1885, at John Street, Adelphi, with £200 borrowed from his mother. In 1887 he removed to Garrick Street, and traded there in his own name until January 1st, 1900, when the business was converted into a limited company styled Harry South & Co., Ltd. The company went into liquidation at the end of 1901, and the creditors are expected to be paid in full. A receiving order was made against the debtor last April. He attributes his insolvency to the failure of the company and losses in his own business owing to competition and differences with customers. Mr. Boyle, assistant receiver, reported that the debtor had only just handed in his statement of affairs, for which reason he was unable to proceed with the examination at that sitting. By consent of all parties the hearing was adjourned for four weeks. The accounts show unsecured debts £467; a partly secured debt, £105 (security valued at £100); contingent liabilities, £680 7s. 2d. (not expected to rank); preferential claims, £152 3s. 4d.; and assets valued at £35 4s. 6d. Appended is a list of the principal creditors, viz.:—

Unsecured.	
Ashby & Co., Staines	£44 8 0
Behrend, R. H., Surrey Street, W.C.	110 0 0
Glaisier, W. B., 47, Essex Street, W.C.	40 9 2
Hands, A., 44, Lincoln's Inn Fields, W.C.	10 10 0
Haines, W. H., Windsor	65 0 0
Wheatley, M. L., Richmond	110 10 1
Slark, Edwards & Co., Southampton Street, Strand	22 3 5
Phillips, H., St. Margaret's	42 0 0
Partly Secured.	
Bradford, S., Hart Street, W.C. (security valued at £100)	105 0 0
Contingent Liabilities.	
Harry South & Co., Ltd. (Liquidator of), Lothbury, E.C.	500 0 0
Smith, A. J. H., 5, Copthall Buildings, E.C.	175 0 0
Preferential.	
Rent	120 0 0
Income-tax and wages	32 3 4

Dissolutions and Liquidations.—Messrs. Heaton and Smith, Ltd., are in voluntary liquidation, Mr. J. T. Garnett, of 22, Booth Street, Manchester, having been appointed liquidator on May 25th. We understand that the liabilities are about £8,300, and there are book debts of the estimated value of £2,000. The other assets consisting of land, buildings, machinery, &c, were recently valued at £8,536, and the stock in trade at £8,149. There are £5,000 debentures.

Messrs. Sykes, Richardson & Hill, electrical engineers, of Glasgow, have dissolved partnership. Mr. Sykes will carry on the business at 8, Dixon Street, and Mr. Hill will control that at Pollokshaws Road, Strathbungo, Glasgow.

Messrs. A. Maund and W. H. Robson (Maund & Robson, electrical and mechanical engineers and contractors, of Southport, Manchester and Wigan) have dissolved partnership. Mr. Maund will attend to debts, and will carry on the business.

Messrs. C. Wray and J. H. Ashworth (Wray & Ashworth, electrical and mechanical engineers, Bradford) have dissolved partnership. Mr. Wray will attend to debts.

The City and Suburban Electric Carriage Co. is to be wound up voluntarily, and a new company with the name the City and Suburban Electric Carriage Co. (1903), Ltd., is to be registered. Mr. W. M. Mason, the secretary, is liquidator.

Brush.—Looking back upon the inception and growth of the electrical industry, there are few names so prominently associated with Great Britain's share in its progress as that of the Brush Co. Such trials and difficulties as have affected the career of that undertaking have been those peculiar to the industry in this country, and its management has always taken a prominent part in the struggle to remove those legislative and other obstacles which have beset the path of the British electrical engineer. In the face of these adverse conditions at home, and the greater encouragement afforded to foreign firms abroad, the Brush Co. has always shown a strong vitality, and now that the times are changing and the necessity for electric power and traction projects on a comprehensive scale is meeting with public recognition, the extensive resources and connections of the company place it in a position of considerable influence. The association with the B.E.T. organisation, which now extends to the Colonies, should be of great practical advantage in relation to continuity of business and of technical experience. Considerable developments have been taking place at the London headquarters and at the Falcon Works, Loughborough, during the past 12 months, and we have reason to believe that the modern manufactures of the company are meeting with a steadily increasing demand.

Books Received.—"Graphical Statics Problems," by W. M. Baker, M.A. London: Edward Arnold. Price 2s. 6d.

"Elektrische Apparate für Starkstrom," by George J. Erlacher. Hannover, Verlag von Gebruder Janecke. Price 8 m.

"Students' Guide to Submarine Cable Testing," by H. K. C. Fisher and J. C. H. Darby. London: The *Electrician* Printing and Publishing Co., Ltd. Price 7s. 6d.

Superheating.—Messrs. Easton & Co. have during the past few weeks received orders for superheater plants aggregating upwards of 7,000 H.P., including plant for the electricity works at Blackpool.

Electrical Progress in Egypt.—The German Consul at Cairo has lately drawn up an interesting report on the present position of electric lighting and engineering in Egypt, which is dealt with at length in *L'Electricien*, and from which we may quote a few remarks. The physical conditions of the country do not lend themselves to the employment of electrical energy on a large scale. Water-power not being available, there is no alternative but to resort to steam engines or other systems of power production. Notwithstanding this, electric lighting has been adopted in Cairo, Alexandria, and in many of the large provincial towns, among which may be mentioned Mansourah (33,580 inhabitants), Tantah (57,000), Zifta (14,000), Heluan (3,000), Suez (25,000) and Ismailia (7,000). At the present time, too, installations are in hand at Assiout (119,000), Fayoum (31,000), Zagazig (32,000), and Damanhour (32,000).

In Cairo the gas company, under a 30 years' concession granted in 1897, controls the supply of electrical energy for lighting purposes. The stations of the company are equipped with six steam engines, of, collectively, 1,200 H.P., driving six dynamos of a normal capacity of 800 KW. In 1901 the number of clients supplied was 1,230, representing 7,000 lamps, an increase of 36 per cent. over 1900. The underground mains extended to a length of 45 miles, and the price charged for current was 1 franc per kilowatt-hour. The stations and mains of the company will become the property of the Government at the end of the term of the concession. There are also a number of private installations in Cairo, ranging in capacity from 20 H.P. upwards. The State Printing Works has a 26-H.P. plant, by means of which the buildings are lighted and the printing machines driven; the Abassije Hospital, on the outskirts of the city, is lighted from its own small plant; the Vice-Royal Opera House has a small station comprising two 25-H.P. dynamos, furnishing the necessary current for 850 incandescent and 6 arc lamps; while, finally, it may be mentioned that two of the largest hotels in Cairo have their own electric lighting plants.

At Alexandria the gas company also furnishes the current for the electric lighting, but in this case the concession is held from the municipal authorities and not from the Government. At neither Cairo nor Alexandria are the streets lighted by electricity, and in this regard the two large cities of Egypt are behind the other towns in the country in which electric lighting is available.

The plants at Mansourah, Suez and Heluan are English enterprises, while that at Ismailia is a Swiss undertaking. The station at Mansourah has a capacity of 60 H.P., this furnishing the current for 373 lamps for public street lighting and a number approximately equal for private lighting. The streets of Heluan are lighted by 200 lanterns, each containing two incandescent lamps. The station is larger than that at Mansourah, being of 130 H.P. capacity, current having to be furnished in the winter season to three large hotels.

One station furnishes the current for the towns of Tantah and Zifta, where it is used, not only for lighting, but also for the operation of pumps. The current is generated at 10,000 volts, and reduced to the necessary pressure at transformer stations.

Although the application of electricity to industrial purposes has not yet made much progress in Egypt, the reverse is the case as regards tramway operation, Cairo and Alexandria both being equipped with electric tramways. The power station of the Cairo tramways, which belong to a Belgian company, is equipped with four steam engines of from 350 to 400 H.P. each, each driving a dynamo of 200 KW. capacity. The length of the lines at the end of 1901 was about 24 miles, of which 13 miles was double track. The rolling stock comprises 94 motor-cars and 59 trailers, the number of passengers carried in 1901 being 14,750,000. The concession granted in 1896 is for a period of 50 years, at the end of which time the system and plant become the property of the State. The capital of the company is £240,000; in 1901 the receipts were nearly £80,000, the total expenses being about 52 per cent. of this.

In summarising his report, the Consul considers that there is a fair market in Egypt for small dynamos, motors and for lighting accessories. Hitherto the dynamos used have been mainly of English and Swiss manufacture, but American machines have lately made their appearance. As regards steam engines, Messrs. Sulzer, the well-known Swiss builders, appear to control the trade, while with respect to gas engines, the high price of gas in Cairo prevents their use on a large scale.

The Allgemeine Electricitäts Gesellschaft, of Berlin, recently established an underground telephone line between Cairo and Alexandria for the Société Egyptiennes des Telephones, while Messrs. Siemens & Halske, of Berlin, installed the necessary electrical apparatus at the great Assouan dam, and have secured the contract for the electric lighting of the barracks at Khartoum.

The appended table shows the imports of electric plant and apparatus into Egypt during 1901 and the preceding two years in Egyptian £:—

	1901.	1900.	1899.
Germany	23,099	15,483	12,947
Austria and Hungary ...	6,877	10,984	16,430
France	2,622	3,218	5,926
England	4,314	3,828	5,791
Italy	1,904	2,176	862
Sweden	2,208	327	163
United States	67	536	5,898

The increase in the Swedish imports is due to the fact that the telephone company is now using Swedish instruments exclusively.

Bavaria.—Large new works for the production of calcium carbide are about to be established near Zwickau, Bavaria. The water-power of the Wolfsteiner Ohe is to be utilised in the generation of the necessary electrical energy, and it is estimated that 2,000 H.P. will be available. Messrs. Escher, Wyss & Co., of Zurich, will supply the turbines, and the Allgemeine Electricitäts Gesellschaft, of Berlin, the electrical plant.

Paper Mill Installation.—The White Mountain Paper Co., of New Hampshire, has recently purchased apparatus which it is said will, when in operation, form the largest individual electrical plant in any paper mill in the world. This consists of three 1,000-KW. and one 300-KW. Westinghouse three-phase, engine-type alternators, complete with exciters and direct-connected to Hamilton-Corliss engines. The various machines in the paper-mill will be operated by Westinghouse type "C" polyphase induction motors of an aggregate capacity of no less than 5,500 H.P.

Trade Announcements.—Messrs. W. T. Henley's Telegraph Works Co. announce that their agency agreement with Messrs. L. Andrew & Co., of Manchester, having expired, they have opened a branch warehouse at 247, Deansgate, Manchester, where a large stock of all standard classes of cable will be kept. This branch Messrs. Henley have placed under the management of Mr. R. S. Page, who has been for many years in the company's service, to whom all communications from customers in Lancashire and Cheshire should be addressed in future.

Messrs. Edwin Danks & Co. (Oldbury), Ltd., boiler makers, have opened a London office at 52, Lime Street, in charge of Mr. James Gordon, A.M.I.Mech.E., to whom all inquiries should be sent from London and district, Surrey, Kent and Essex.

Parliamentary.—STANDING ORDERS.—On Tuesday Mr. Jeune, Examiner, found Standing Orders complied with in the case of the following Bills:—Tynemouth and District Tramways, Worthing Corporation Tramways, London, Brighton and South Coast Railway, Aston Manor Improvement, Hastings Tramways (extensions), South Lancashire Tramways, Dewsbury, Batley and Bristol Tramways, Chard Corporation Gas and Electricity, Pontypridd U.D.C., Preston, Chorley and Horwich Tramways, and the Scottish Central Electric Power.

New Committees.—A new Committee, consisting of Sir E. Strachey (Chairman), Mr. Peel, Mr. Mooney and Mr. Morrison, has been appointed to consider the following Bills:—Croydon and District Electric Tramways, Harrow Road and Paddington Tramways, Ulster and Connaught Light Railways, and Baker Street and Waterloo Railway (Extension of Time). A Committee, consisting of Mr. Geo. Whiteley (Chairman), Sir Charles Welby, Mr. H. Law and Mr. Beresford Melville, will consider the Electric Light Provisional Orders Bills, Nos. 5 and 7.

Scottish Central Electric Power Bill.—The Chairman of Ways and Means has reported that, after conferring with the Chairman of Committees of the House of Lords, it has been decided that the above Bill shall originate in the House of Lords.

Catalogues and Lists.—The SUN ELECTRICAL CO., LTD., of Charing Cross Road, W.C., has published a new fan list for the current season. Various types of motor fans for alternating and continuous current circuits, and for various positions, are priced and detailed.

A new price list of small "M. W." motor generators, motor alternators, and motor transformers, has been issued by MESSRS. MARSHALL & WOODS, of Gray's Inn Road, W.C.; a similar list relates to the "M. W." miniature electric motor. The firm makes a speciality of these small machines.

The NEW CENTURY ARC LIGHT CO., of Walworth, has brought out a new catalogue detailing the advantages, prices, and some of the more important users of the New Century arc lamp. The lamps are now being made to meet varied requirements, and considerable reductions have been made in all prices.

The VACUUM OIL CO., LTD., of York House, Norfolk Street, W.C., who have made a study of lubrication for the past 30 years and more, have issued a treatise on "Oil and Power." It is an attractive and instructive pamphlet, in which many features of the lubrication question and its relation to economy and freedom from trouble in power production are discussed, and many neat little pictures of the company's works at Rochester, U.S.A., are published. A copy of the *brochure* will be sent on application at York House.

MR. HERMANN KUHNE, of 28, Victoria Street, S.W., has acquired the sole agency of the "Proell" patent metallic stuffing box for the United Kingdom and Colonies. We gather from some lists which he is now circulating that this packing is already in use in engines up to 14,000 H.P., and is working satisfactorily under high temperatures of superheat. Mr. Kühne will send illustrated descriptive circulars on application.

A pamphlet relating to the E.C. electric fans and ventilators has come to hand from the ELECTRICAL CO., LTD., of Charing Cross Road. A number of neat pictures of different designs appear, also dimensional drawings. Automatic air valves for electric fans with wall rings are illustrated. Prices are given for desk, wall and ceiling fans.

MESSRS. E. GOOSSENS, POPE & CO., of Guildhall Chambers, Basinghall Street, E.C., have just issued from the press a new catalogue showing numerous types of incandescent electric lamps, which are representative of the various styles now in demand. They hold large stocks at their London, Liverpool and Glasgow depôts. Pope's patent plasterless cap, which is first described, is claimed to give increased insulation efficiency, to obviate loose caps, and to stand exposure in the open air or in damp places. The illustrations in the list are very well done, and are not too small. The types shown include high and low-voltage lamps of ordinary shapes, also tubular, twisted and plain flame, ship lighting and traction lamps. Prices are given per dozen for lamps and for extras.

MESSRS. D. ANDERSON & SON, LTD., of Lagan Felt Works, Belfast, have issued a second edition of their illustrated pamphlet relating to silicate cotton (slag wool) for insulation, fireproofing and roofing purposes. The material is also used in the forms of cloth and rope for covering boilers and steam piping.

From the Electric and Ordnance Accessories Co., Ltd., of Birmingham, we have received a list showing the Stellite electric fans as designed for table, bracket, ceiling and porthole use. Parts of the fans are shown in detail.

Wright's Meter.—We learn that the Wright's electrolytic meter, made by the Reason Manufacturing Co., has now been approved by the Board of Trade.

Bad Trade.—Messrs. Clayton & Co., electrical engineers, Union Works, Huddersfield, announce that owing to bad trade they are compelled to close their works, and cannot accept further orders from June 8th. Work now in hand is to be completed as early as possible.

Belliss Engine.—Messrs. Tasker's Engineering Co., of Sheffield, have placed a sub-contract with Belliss & Morcom for two 300-B.H.P. quick revolution engines for electric power work.

For Sale.—The date for sending in tenders for the Halifax plant has been altered from June 9th to 23rd.

About a Fulham Contract.—The Borough Council at last week's meeting passed a resolution appointing a committee to "inquire into and report upon the remarkable letter received by the Town Clerk on January 28th, 1902, from the British Insulated Wire Co." The letter referred to related to a tender of the company's which was at that time before the Council, and it offered a reduction of 5¾ per cent. from the prices quoted in consequence of an alleged "big slump in copper," which had enabled them to buy "large quantities at bottom prices." Mr. Scriven, who moved the resolution, said that it was an injustice to allow a revised tender to intervene.

ELECTRIC LIGHT AND POWER NOTES.

Accrington.—A loan of £550 for the provision of a booster at the electricity works has been applied for.

Batley.—The T.C. has applied to the L.G.B. for a loan of £5,000 for the extension of the electric light cables.

Birkenhead.—The T.C. has decided that from July 1st ordinary consumers in the borough shall be allowed the option of paying, on notice, a flat rate of 5d. per unit, instead of at the rate based upon the maximum demand.

With regard to the proposed extension of the E.L. mains to Upton and Prenton, which are outside the borough, the electrical engineer (Mr. Wm. Bates) reports that to serve Upton there would be an expenditure of £2,401, and the residents had guaranteed a minimum revenue of £200 per annum for five years. The outlay for supplying Prenton would be £3,833, and there was hope that before long the demand from Prenton would become a profitable source of revenue.

Blairgowrie and Rattray, N.B.—The committee representing the T.C.'s of these two burghs to deal with the question of electric lighting, have agreed to ask Mr. Lowden, Dundee, and Mr. Hawtrey, London, to make offers for its introduction, the engineers to bear all expenses, including the cost of a provisional order, and undertaking all responsibilities and risks connected with the work, the burghs on their part promising to give the lighting of the streets to the company successful in getting the contract, on the understanding that the cost would be at least as cheap as gas.

Bolton.—At the meeting of the T.C. on June 4th the Electricity Committee reported that the gross profit on the undertaking was £20,807, against £17,319 last year, and out of this £4,500 had been granted in relief of the rates.

It was decided to reduce the price of electricity to 4d. per B.T.U., less 10 per cent., and 1½d. per unit for the tramways. The penny-in-the-slot system is to be extended.

Bristol.—The Corporation Electrical Committee recommends the T.C. to apply to the L.G.B. for a loan of £10,000 for the purpose of equipping premises with the electric light. Under the Bristol Corporation Act, 1902, powers were obtained to supply electric motors, fittings, apparatus, &c., and to wire premises, and the Committee is of opinion that the initial cost of wiring prevents many persons from becoming consumers.

Bury (Lancs.).—The T.C. has offered to supply electricity to the Whitefield U.D.C. for 7d. per unit for general supply on the maximum demand system, for one hour per day, and 1d. per unit afterwards, a flat rate of 5d. per unit for domestic supply, and 4d. for the first hour per day and 1d. afterwards for motive power and heating.

Canterbury.—The T.C. has decided to apply to the L.G.B. for a loan of £4,000 for electric lighting purposes, including £1,616 16s. 4d. for mains, services, meters, and public lamps.

Carnarvon. — The E.L. Committee recommends the T.C. not to undertake the construction of electric lighting works, but to enter into an agreement with the National Electric Wiring Co. to construct the works and supply current, the Corporation to have the option of purchase at the end of 10, 15 or 20 years.

Clydebank, N.B.—The T.C. has received a deputation from the Clyde Valley Electric Power Co., who offer to supply electricity in bulk to the borough, in lieu of the Council putting down a dust destructor and electricity works combined. At the same time the supplementary report of the proposed works received from the consulting engineers, Messrs Kincaid, Waller, Manville and Dawson was considered. Sir David Richmond, who headed the Clyde Valley Co.'s deputation, stated that they would have a 20,000-H.P. station ready in 18 months at Yoker, two miles distant. After considerable discussion, the Council suggested that the Clyde Valley Co. should submit an offer to destroy the borough refuse in addition to supplying energy.

Colchester.—The Corporation Electricity Committee reports that the year's working resulted in a net profit of £357 6s. 5d., which has been placed to the reserve and renewal fund. By abolishing meter rents and allowing a discount of 5 per cent., the profit was reduced by £311.

Coventry.—The accounts of the electricity department for the past year show a total revenue of £3,076 and working expenditure of £3,691, leaving a gross profit of £4,385. Capital charges amount to £4,574, being a net deficit of £189. The Committee has resolved to recommend the City Council to apply for sanction to borrow the additional sum of £5,000 for the purchase of motors to be let out on hire.

Darlington.—A net profit of £180 16s. 6d. was made on the E.L. undertaking last year, and this sum has been transferred to the depreciation account.

A loan of £7,000 for new mains, services and meters, has been applied for by the T.C.

Dumfries.—The Council has decided, by 11 votes to 9, to enter into negotiations with Messrs. Frank Suter & Co., to carry out the electric installation in the town with a view to coming to an agreement.

Eastbourne.—During the year ended March 31st last the T.C. made a gross profit of £10,547 on the working of the electrical department. The total income was £17,809 and the expenditure £7,262. After meeting financial charges there is a net surplus amounting to £2,814. At the last meeting of the Council it was stated that it is hoped next year to further reduce the price per unit, which during the past year has been lowered from 7½d. to 6½d.

Felixstowe.—The U.D.C. has signed an agreement with the Suffolk Electric Supply Co. for the supply of electricity at 3½d. per unit.

Glasgow.—An interesting debate on the generation of electricity in the Corporation electricity and tramways departments, took place at the Council meeting on 4th inst. As is well known, the lighting department generates current at 500-volts pressure for lighting and power purposes. The tramways department generates three-phase current at 6,500, and transform down to 500 volts direct-current for its own use on the tramway system. The tramways department having put down plant greatly in excess of the present requirements, the lighting department has agreed to take energy from it during the winter months at 1½d. per B.T.U., thus obviating an increase in the lighting department's plant. In this connection it may be interesting to point out that the record load on the tramways generating station at Pinkston on May 13th, 1903 (the night preceding the Royal visit), was 520 amperes, and the total capacity of the plant is 22,000 H.P.

Bailie Stevenson, the senior magistrate, submitted a motion, "That the Council, being satisfied that economy and efficiency are sacrificed through the production of electric energy being entrusted to two departments, resolves that the entire production, both for power and light, be put under one control, and that it be remitted to the Electricity and Tramways Committees to confer and report how this could best be done." In supporting his motion, he pointed out that several attempts had been made, notably in 1897 by Sir David Richmond, to carry out the policy be adopted.

Bailie Shaw, a well-known engineer in Glasgow, moved that a special committee be appointed to report on the subject. Knowing as he did the antagonism between the two committees, he was afraid Bailie Stevenson's motion would never be carried out.

Bailie Stevenson withdrew his motion, and seconded that of Bailie Shaw.

Bailie Alexander moved the previous question, and after considerable debate the Council divided, 22 for inquiry and report, and 22 for the existing arrangements.

The Lord Provost, Sir John Ure Primrose, Bart., gave his casting vote for the existing arrangement, so that it will be another six months before this subject can be brought up again under the standing orders.

Heckmondwike.—At a recent meeting of the U.D.C. a statement was submitted showing the cost of the electric lighting station, baths and fire station, which have been recently erected, and which comprise one building. The total cost of the electricity department, including unfinished contracts, has been £27,154. A further extension is contemplated, and application is to be made for sanction to borrow £7,157 for this purpose. Originally the electricity works were estimated to cost £14,000, but considerable additions were made to meet the requirements of the British Electric Traction Co., who are now running cars through the district.

Hastings.—The T.C. has applied to the L.G.B. for loans of £3,000 for new mains for two years, £1,500 for house services and £1,500 for meters.

Italy.—Application has been made for a concession to put down a plant to utilise the water-power of the River Ponzate, at Ponzate (Como), in the generation of electrical energy for lighting purposes.

Kingstown U.D.C., Ireland.—The E.L. Committee recommend for the approval of the Council the form of contract submitted by Edmundson's Electric Lighting Corporation, the installation to be carried out by the company on a schedule of prices to be agreed upon, the Council to borrow the necessary capital, which would include the full amount which the Council is liable to pay on account of the scheme. If the Council approved of the general terms of the contract and agreed upon prices, the Committee recommended that application be made to the Local Government Board for sanction to borrow a loan for the amount required, not exceeding £40,000.

Leigh.—A gross profit of £1,433 was made on the last year's working of the electricity department of that Corporation. The net surplus was £263.

Lewes.—With the consent of the B. of T. the name of the County of Sussex Electrical Power Distribution Co., Ltd., has been changed to that of the Lewes and District Electric Supply Co., Ltd.

Liverpool.—Reports which have been submitted by the city electrical engineer to the Electric Power and Lighting Committee, state that the total road mileage of the tramway routes is 57¼ miles, 4 miles of which are electrically lighted. To utilise the tramway poles for arc lighting in accordance with the new scheme of street lighting, would necessitate, approximately, the use of 2,054 lamps over the entire tramway routes. It is estimated that 508 additional electric columns would have to be provided. Main thoroughfares not on the tramway routes, having a total length of four miles, are reported upon. These would require, approximately, 145 lamps, if placed 55 yds. apart. The approximate first cost and additional annual cost of carrying out the proposed scheme, exclusive of the cost of additional generating plant, is given in one report as follows:—Wiring and equipping lamps, switches, &c., on 1,546 tram poles, at £77 each, £119,042; wiring and equipping lamps, switches, &c., on 653 electric lamp pillars, at £84 10s. each, £55,178 10s.—£174,220 10s., credited by cost of 3,278 gas lamps, pillars, &c., discontinued, at £1 5s. each, £4,097 10s.; total first cost, £170,123. Annual cost of 2,199 lamps at £16 12s. each, £36,503 8s., credited by present cost of gas lighting, £8,856 5s. 1d.; total additional cost, £27,647 2s. 11d. In order to carry out the scheme in its entirety, it would, the resident engineer states, be necessary to add, say, 2,000 H.P. to the generating plant in the stations and to lay additional street mains. The engineer estimates the capital expenditure necessary for the plant and mains referred to as approximately £50,000.

Longton.—Having been petitioned to adopt a flat rate of charge for electricity, the T.C. has appointed a committee to consider the matter.

London.—ISLINGTON.—The unbusinesslike methods of the Electric Lighting Committee were severely commented upon at the Borough Council meeting on Friday last. Some weeks ago the Committee recommended for acceptance the tender of the British Insulated and Helsby Cables, Ltd, for laying mains in the Hornsey and Canonbury districts. The tender was not the lowest, and the matter was referred back for a report of the Joint Finance and Lighting Committee. This Committee brought up a recommendation that the contract with the British Insulated and Helsby Cables be sealed. Alderman Cufflin said the Electric Lighting Committee had spent £50 in printing a specification for a contract of £5,000 or £6,000, and yet when this pamphlet of 64 pages came to be read, there was nothing definitely specified in it. They did not state what was the size or weight of the cable or the thickness of the insulation. Neither did they specify the size, shape or capacity of the boxes, and yet in the engineer's report the Council was informed that upon the size and construction of the boxes practically everything depended. The Committee might have put in the minimum capacity of the boxes which they would consider suitable for the conditions attached to the contract. Yet they did nothing of the kind, and allowed three firms to go to the expense and trouble of wading through plans and making it all out, and then threw them on one side on the ground that their boxes were not of the size required. After getting in those tenders their engineer—the only expert on the Committee—told them that the choice lay between the two lowest tenders and one other firm which had had a more extended experience. After the unbusinesslike action of the Committee, he thought it was the duty of the Council to refer the matter back, in order that inquiries might be made as to the stability of the firms tendering the lowest prices, and their ability to carry out the work. By 23 votes to 16 the recommendation was referred back. It was agreed to call a conference of the Borough Councils north of the Thames, in order that united action might be taken to secure uniformity of system with regard to the electrification of the tramways.

MARYLEBONE.—Opposition to the proposed taking over by the municipality of the undertaking of the Metropolitan Electric Supply Co. is growing. It has been arranged that Mr. Edward White, L.C.C., will introduce a deputation of ratepayers to the Finance Committee of the L.C.C. on the 17th inst., to protest against a loan being sanctioned. In a recent report the Electric Supply Committee recommend the appointment of a deputation to represent their views. The report further states that a letter has been received from the solicitor to the L.C.C., to the effect that the Finance Committee was not at present in a position to arrive at a decision as to whether it was practicable or not to issue a conditional sanction to the loan, and before further considering the question it desired to learn whether on the assumption that such sanction were issued, the Metropolitan Supply Co. "would be willing to complete the sale of the undertaking without requiring cash payment of the purchase money in consideration of an undertaking to find the money, which undertaking should be accepted as the consideration," and, further, whether, if the purchase is completed in this manner, the Board of Trade would be prepared to forthwith fix a date for the commencement of the Borough Council's Order as provided by Sec. 3 of the Electric Lighting Orders Confirmation (No. 1) Act, 1901, and requesting that if the Borough Council should be in a position to reply affirmatively to these questions they should procure and furnish to the L.C.C. letters from the company and the Board of Trade, showing their willingness to adopt the course proposed. The Committee decided to communicate with the company and the Board of Trade, asking if they are prepared to give such letters as the London County Council require. The report goes on to say that the company's costs in the arbitration proceedings were delivered at £21,048 12s. 10d., and had been taxed at £10,698 18s. 1d. This amount was allowed, and had been referred to the Finance Committee for payment.

HACKNEY.—As an experiment, the Electric Lighting Committee of the Borough Council decided this week in favour of lighting three roads in which electric distributing mains have already been laid by means of 40 small arc lamps, in lieu of the 91 existing gas lamps, at an extra cost of £320 16s. 7d. per annum.

STEPNEY.—Upon the recommendation of Mr. W. Tapper, the borough electrical engineer and manager, the Electric Lighting Committee has decided in favour of appointing two additional officers—a senior analysis (time and material) and prime cost clerk, and an assistant analysis and prime cost clerk. Mr. Tapper reported that the work had outgrown the staff to such an extent that during the past 12 months the clerks had been almost continually doing overtime, for which they received no extra remuneration. Notwithstanding the overtime, the work was still very much behind. The forthcoming balance-sheet would, in his opinion, more than satisfy the Council as to there being a balance on the right side.

BATTERSEA.—On Wednesday it was reported to the Borough Council that the agreement with the County of London and Brush Provincial Electric Lighting Co., Ltd., for the transfer of areas in connection with the Electric Lighting (London) Bill having been completed, and the Board of Trade seeing no objection to the terms of the agreement, the Council's petition against the Bill had been withdrawn.

Londonderry.—A curious difficulty has arisen in connection with the loan of £35,000 required for the Council's private electric lighting scheme. The L.G.B. sanctioned the issue of stock for that amount at 3 per cent. and at not less than 95. There were few offers from the public, and the Corporation applied to the Board of Works for a loan. This was refused on the grounds that the scheme was a commercial speculation. The Finance Committee has now determined to recommend the issue of mortgages on the security of the rates, the debentures to bear such interest as can be arranged with the investors.

Macclesfield.—The T.C. has asked two firms to tender for a complete electrical installation for the borough. The works are to be erected on Corporation ground, and it is stipulated that the machinery must be of British manufacture.

Maidstone.—A loan of £7,000 has been applied for by the T.C. for electric lighting purposes.

The electric lighting mains are to be extended to St. Peter Street at a cost of £426 6s.

Mexico.—La Compagnie d'Electricité de Hidalgo has obtained a concession from the Mexican Government to put down a plant to utilise the water power of the lakes of Chalco and Xochimilco, estimated at 1,000 H.P.

Middlesbrough.—The Corporation E.L. Committee has recommended extensions of the electric light mains to Linthorpe, at a cost of £2,434, and to Grove Hill, at a cost of £2,284.

Newport (Mon.).—The annual report on the Corporation's electricity undertaking shows a gross profit of £7,584, and a net profit of £1,340. In the previous year the respective figures were £6,431 and £859.

Northfleet.—The U.D.C. has decided to apply for an extension of time in which to carry out the E.L. order.

Nottingham.—The annual report of the Electricity Committee states that the demand for electricity is still increasing both for lighting and power purposes. The first portion of plant ordered for the St. Ann's power station is now complete, and the whole of the traction load was transferred to this station in December. The plant installed consists of eight Lancashire boilers with mechanical stokers and coal conveyors, four steam dynamos of 700 H.P. each, and two feed pumps, &c. The total horse-power installed at the two generating stations is as follows:—Talbot Street, 8,925 H.P.; St. Ann's, 2,800 H.P.—total, 11,725 H.P. Two additional steam dynamos, each of 700 H.P., are now in course of erection at the St. Ann's power station. The distributing mains have been extended in 74 directions, the total extension being 6·39 miles. The number of applications received

for a supply of electricity on March 31st was 2,238, as compared with 1,867 on March 31st, 1902. The number of 8-c.p. lamps or their equivalent connected up on March 31st was 208,306, as compared with 170,826 on March 31st last year. The total number of units sold during the year was 6,510,476. For the year ended March 31st, 1902, 4,094,897 units were sold, showing an increase for the past year of 59 per cent. The number of motors connected to the mains is 392, the total horse-power being 1,346. The statement of receipts and expenditure on capital account shows that the total outlay up to March 31st, including that for tramway purposes, had been £374,478 19s. 9d., the expenditure for the past year having been £58,335 9s. 2d. The balance on the year is £48,179 17s. 3d. The revenue account shows the past year's income to have been £60,610 17s. 11d. The sinking fund account shows the amount invested during the year to have been £7,975 3s. 9d., and the interest on investments £175 11s. 10d. From the repayment of loans account it appears that £14,455 had been repaid up to March 31st, 1902, and £6,965 during the subsequent 12 months. The amount of balance on the reserve fund account is £15,480, and the total liabilities on the electricity supply account stand at £408,031. Of this £111,565 is for tramway purposes, under this heading being £34,223 for buildings, £39,547 for machinery, and £32,189 for mains.

Peterborough.—The T.C. has decided to have Oundle Road, the Bridge, Priestgate and Wentworth Street lit by electricity.

Pontypridd.—The South Wales Electric Power Distribution Co. has offered to supply energy to the U.D.C. for E.L. and tramway purposes on the following terms:—For a minimum of 1,000,000 units per annum, 1d. per unit, plus ½d. for transformation, and less 10 per cent for constant use of energy during the 24 hours.

Portsmouth.—From the balance-sheet submitted to the E.L. Committee of the T.C. it appears that the income for the past year was £35,455 against £32,295 in the previous year. The profit was £3,185, compared with £4,000 last year. It was decided to recommend that £2,000 be placed to reserve, that £1,000 go towards the relief of the rates, and that £185 be carried forward to next year's account.

Sevenoaks.—The U.D.C. has secured from the Kent Electric Power Syndicate, Ltd, which is applying for a prov. order to supply the town, a clause giving a definite assurance that the company will proceed to actually instal the electric supply within a year after the confirmation of the Act.

Sheffield.—The returns for the year 1902-3 show a surplus of £6,533, the largest yet earned in any one year. In the preceding 12 months it was £5,604; for 1900-1 (15 months) it was £4,018; for 1899 it £914; and for 1898 £1,330. It appears that the total output for the year under review was 2,919,722 units, against 2,487,584 units in the previous year. Since the Corporation took over the undertaking, the yearly output has just trebled, the total revenue is about 2½ times as much as in the first year of Corporation management. Since March, 1901, the number of 8-c.p. lamps installed has gone steadily up from 130,000 to 210,000, the actual increase in the last 12 months being from 165,000 to 210,000. The maximum number of 8-c.p. lamps, or their equivalent, alight at one time was, at the end of January this year, about 86,000. The previous year's maximum, which occurred at the end of February, was about 79,000.

Southport.—The Corporation's electricity undertaking shows a gross profit for the past year of £12,363, of which sum £10,577 will be devoted to interest and sinking fund, leaving the net profit £1,786, or £102 more than in the previous year. The capital account stands at £172,832, and since the commencement of the undertaking £20,000 has been paid off through the operation of the sinking fund. The number of consumers has grown steadily during the year.

During the past year £12,630 was spent in connection with the Southport electricity works, bringing the capital account up to £175,442 (including £2,110 as value of land). £1,037 was expended on buildings, £1,748 on machinery at the generating station, and £7,418 on mains. Units generated for the year ended March 31st, 1903, were 2,112,962. Units sold to ordinary consumers, 346,470; public lighting, 132,588; tramways, 672,398. 95,377 units were consumed at the works and in testing, and 366,129 absorbed in mains, transformers, &c, the percentage of loss being 24·5 per cent.

Swansea.—The results of the second year's working of the electric lighting department show that the capacity of the plant was equal to 1,725 kw. The maximum load last year was 547 kw. Number of 8-c.p. lamps, 43,112, a gain of 19,946; units sold, 578,182, a gain of 258,957. The first year's working showed a deficit of £349, without including any sum for sinking fund, although a debt of £542 had been wiped off. In the year just ended there was a profit, after providing for interest and sinking fund.

Swindon.—It was reported to the B.G., on June 4th, that the installation of the electric light at the workhouse has cost £1,821 15s. 10d.

Walthamstow.—The municipal electric lighting undertaking for the year ending March 31st last, shows a profit of £3,005 after paying all expenses, including interest and sinking fund.

Walsall.—The Corporation Electric Lighting Committee reported that the Local Government Board had sanctioned a loan of £16,032, being part of the application made for a loan of £24,550, and had intimated that when the sites for the various sub-stations had been obtained they would consider the question of sanctioning a loan for the balance.

Willesden.—The *London Gazette* for June 9th contains notice of the application which is to be made to Parliament this session for an Act giving power to the Willesden U.D.C. to sell, and to the North Metropolitan Electric Power Supply Co. to purchase, the electricity works and undertaking.

Winchburgh (N.B.).—The Oakbank Oil Co., Ltd., propose the electric lighting of the streets in the part of Winchburgh which is their property. Energy will be supplied by generating machinery at the oil works.

ELECTRIC TRACTION NOTES.

Blackburn.—On June 4th the T.C. decided to extend the electric tramways to Cherry Tree, at an estimated cost of from £5,500 to £6,000, and to Audley, at a cost of about £8,500. A third proposed extension to Revidge, at a cost of £8,000, was rejected.

Brighton.—As a result of the first completed year's working of the electric tramways there has been a net surplus of £4,135 made. The sum of £3,051 paid out of the rates to make up the adverse balance to March, 1902, has now been repaid, and the balance, a sum of £1,084, has been set aside to form the nucleus of a depreciation and general reserve fund. According to the chairman of the Committee the Corporation charged on the average ¾d. a mile, and carried over 14,000,000 passengers without a single accident, notwithstanding the severe conditions as to gradients. The total revenue was £43,700 3s. 4d. The expenditure was:—Wages of inspectors, motormen, conductors, &c., £13,037; electrical energy, £9,301; miscellaneous, £1,238; and repairs and renewals, £4,427; management, £2,676; rent, rates and taxes, £936; total, £31,615. The amount carried to net revenue is thus £12,085. Interest absorbs £6,171; sinking fund, £1,779; the loss on working up to March, 1902, was £3,051, and there is carried to general reserve fund £1,084.

Dublin.—Last week a public meeting was held here for the purpose of taking steps to promote a scheme for the construction of an electric tramway from Dublin to Swords.

Glasgow.—The annual report for the year ending May 31st, 1903, is now being made up. The receipts for the year just ended amount to £653,200, compared with £612,826 for the previous year, being an increase of £40,374.

	1902—3.	1901—2.
Car-miles	14,008,750	12,615,021
Passengers	177,179,549	163,678,190
Miles of track (double)...	65	52

This works out that 11·19d. per car-mile was received in 1902—3, compared with 11·69d. in the previous year. In other words, a decrease of ½d per car-mile was received for the past year, probably accounted for by the fact that the cars now run to the outlying suburbs practically empty during the greater part of the day, and also by the reduction in fares. The amount per passenger received also shows a decrease, being ·88d. per passenger for year 1902—3, compared with ·89d. for the previous year. This is, of course, due to the fact that an additional ½d. stage was given to passengers paying 1d. and upwards during the past year.

The T.C. has authorised the general manager of the tramways to get additional sets of light portable bridges to carry the car traffic over hoses used in the event of fire.

Japan.—The Japan Electric Society, of Tokyo, is approaching the Japanese Government with the view of obtaining a simplification of the procedure to obtain charters for new electric railway schemes.

Leith.—The offer of the T.C. of £60,000 for the purchase of the tramways has been accepted by the directors of the Tramway Co. It is anticipated that the cost of converting the system to electric haulage will be £80,000, and it is said that, with contemplated extensions, the entire cost of the new scheme may reach about £200,000.

London.—It is reported that the L.C.C. has been obliged to appoint two conductors for each car on the Tooting electrical tramways, one being quite insufficient to collect all the fares at the busy periods of the day. This is because of the greater carrying capacity than the old cars, and the short-distance stopping places.

A deputation of the Islington Borough Council recommends the Works Committee to convene a conference of the North London Borough Councils to consider the question of the electrification of the tramways.

Manchester and Salford.—Under the new arrangement between the Manchester and Salford Corporations, Salford electric cars began running into Deansgate, Manchester, last week. The through running has enabled the Salford Corporation to open alternative routes to such outlying places as Peel Green and White-

field, points between which passengers may now travel without changing cars, a distance of 11 miles. Whilst the new arrangement has relieved the congestion on Blackfriars Bridge, which marks the boundary between the city and the borough, it has caused a little confusion in Deansgate, along which there is now a constant stream of tramcars. The difficulty will, no doubt, remedy itself as the public get better acquainted with the service. During the Whitsuntide holidays the tramway traffic in the entire district, as well as in the City and in Salford, was exceptionally heavy.

Nottingham.—At Monday's meeting of the City Council, the Tramways Committee reported that during the year the undertaking had been maintained in good order out of revenue. A revaluation of the lines, depôts and property of the tramway undertaking had been made, and the assessment had been raised to £19,134. The amount paid in rates on such assessment for the past year was £6,179, being an increase of £4,785 over the previous year. The total income during the past 12 months amounted to £115,223. The expenditure in the same period (including interest and sinking fund) amounted to £84,371, leaving a balance of £30,852. Of this balance, £18,000 had been contributed to the general district rate account, and the balance carried to the reserve fund, which, with interest accrued, now amounts to £20,156. Embodied in the Committee's report was the report of Mr. John Aldworth, the manager of the tramways. The receipts were adversely affected by the cold and wet summer, but the loss was largely recouped by the additional traffic during the Coronation festivities, and owing to the mildness of the weather, with freedom from fog and snow, during the winter months. The total number of passengers carried was 24,552,358, and the receipts per mile averaged 13·06d. The expenditure showed the wages of motormen, conductors and inspectors to have amounted to £21,225 (equivalent to 2·406d. per mile), and electrical energy, traction and lighting to £15,117 (or 1·713d. per mile), whilst rents, rates, taxes, and licenses had accounted for £6,780. The total expenditure of £60,873 was equal to 52·83 per cent. of the total receipts. A summarised statement gives the following result:—Total receipts, £115,223 0s. 1d., 13·06d. per mile; working expenses, £60,873 0s. 9d., 6·90d. per mile; interest and sinking fund, £23,498 1s., 2·66d. per mile; and net credit balance, £30,851 18s. 4d., or 3·50d. per mile. The energy used for traction, car and depôt lighting and power for depôt machinery was 2,902,546 units, equal to 1·37 units per car-mile. This was supplied by the electricity department to the tramway feeder boxes at the rate of 1·25d. per unit. The present number of employés in the service of the tramways department is 410. The number of electric cars in stock is 105, of which 89 are equipped with two motors and mounted on single trucks, six equipped with two motors and mounted on two maximum traction trucks, and 10 equipped with four motors and mounted on two equal-wheel trucks. No fatal accident occurred during the year in connection with the working of the undertaking. Eighteen children and adults were either knocked down by the cars or fell on the track, and one threw herself in front of a car travelling at a considerable speed, but all were either picked up or pushed clear of the cars by the life guards without serious injury. All the cars are now being fitted with an improved trolley head, which it is expected will greatly minimise if it does not altogether remove the possibility of accidents by reason of trolleys getting entangled with the overhead equipment. A detailed statement shows that the total amount of liabilities on the tramway undertaking is £555,315.

Alderman Brownsword, in moving the adoption of the report, said that the committee held out no hope either of a further reduction of the fares or of the lengthening of the stages. The fares had already been reduced 20 per cent. on the old rates. The establishment of a penny fare would involve a loss of £10,000 a year. The Committee desired to have a reserve fund for contingencies and renewals, which stood now at £20,000, of £100,000, and in the meantime they could not expect to contribute much more to the rates per year than they had just done—£18,000. The report was adopted.

Oldham.—The financial report of the tramways department for the year ending March 25th, 1903, is as follows:—Expenditure.—Traffic expenses, £17,084; maintenance and repairs, £4,591; establishment charges, £1,273; energy, £15,673; compensation, £1,034; and miscellaneous expenses of various kinds bring the total to £41,864. Income:—Fares, £47,662; advertisements on cars, £260; stores in hand, £2,992; and miscellaneous sums make the total £51,212. The credit side of the net revenue account shows:—Balance from revenue account, £9,348; interest and sinking fund contribution, £517; income-tax, amount deducted from interest paid, £613 8s. 11d; total, £10,479 1s. 11d. Debtor:—Interest on loans, £9,856; contribution to sinking fund, £5,150; interest to sinking fund, £891; bank interest, £2,297; total, £18,194. This leaves a deficiency on the year of £7,715, to which must be added a loss of £3,204 up to March 25th, 1902.

Preston.—The T.C., at its meeting on the 28th ult., decided, by a large majority, to proceed with the municipalisation of the tramways, and accepted the following tenders for the new power station, viz.:—Messrs. Dick, Kerr & Co., Ltd., two 300-kw. dynamos direct coupled to engines by Messrs. Cole, Marchent and Morley, Ltd., for £5,916; Messrs. Yates & Thom, Blackburn, two Lancashire boilers and superheaters, £1,591. The electrical engineer's drawings of the proposed power-station, car-sheds, &c., were approved, and he was authorised to prepare specifications and advertise for tenders for the necessary builder work, condensers, and other auxiliary plant. The lines are at present worked by a local company, whose lease expires on December 31st, 1903. The municipality has procured Parliamentary powers to equip electrically about 14¾ miles of route, equivalent to about 20 miles of single track. The overhead system has been decided upon, and it is proposed to have the new route to Fulwood, *viâ* Deepdale Road, working early in 1904, when the conversion of the whole of the existing routes is to be proceeded with as rapidly as possible.

Rochdale and District.—The property of the Bury, Rochdale and Oldham Tramways Co. is about to be transferred, by arrangement, to the local authorities through whose districts the company's lines pass. The directors of the company have offered terms, which the authorities, at a recent meeting, unanimously resolved to accept, and the Rochdale Corporation and the other authorities concerned will take possession of the tramways within their respective districts from July 31st, paying to the company, from that date until the completion of the purchase, an annual sum equal to the average yearly profits of the last two years.

Salford.—An accident of an unusual kind happened to an electric car last week. Owing to an insufficiency of cars to work the inter-traffic arrangement with Manchester, Salford had to borrow a number of vehicles from the Manchester Corporation, and one of Manchester's large bogie-wheel cars was used upon the race-course traffic. This car was crowded with passengers inside and out, when, some little distance from the race-course, a smell of burning wood was perceived. The car was stopped, and the passengers were asked to leave it, which they did quietly; and an examination revealed the fact that a portion of the internal seating was quite hot. On the seat being lifted, a dense volume of smoke was at once emitted, and, with the admission of air, the gutta-percha coverings of the wires burst into flame. In a few seconds the flame travelled all round the car. A motor inspector of the Salford Corporation took charge of the burning vehicle, and had it removed at full speed to the car depôt in Seaford Road. There the fire was speedily extinguished. The windows of the vehicle were broken, and its interior fittings were completely ruined. The prompt action of the inspector enabled the ordinary traffic to be carried on without interruption. The mishap was found to be due to overheating of the resistance box, which was located in the cavity between the seating and the floor of the car. The box had been covered by a sheet of zinc for the protection of the seat, but this seemed rather to have aggravated the mischief. The Manchester authorities have arranged for a change to be made in the position of these boxes in their cars. They will in future be located underneath the platforms, as in the Salford cars, so that any further mishap from the same cause will be avoided.

Sheffield.—The tramways accounts show that the profit for the past 12 months amounts to over £28,000, out of which nearly £14,000 is recommended for the relief of the rates.

Stretford.—It was reported at the last meeting of the Stretford Urban District Council that the amount apportioned to Stretford under the arbitrator's award in the dispute between the Manchester Carriage and Tramways Co. and the Manchester Corporation and local authorities was £73,149, brought down on appeal from £163,000 to that figure. The district has been apportioned the Chorlton Road and Stretford tramway depôts, which are within its area.

Councillor Johnson has resigned his position as chairman of the Stretford Electricity and Tramways Committee on account of ill-health. His services in maturing the electricity scheme for the district, and during the lengthy negotiations for the acquisition of the tramway lines and their reconstruction for electric traction, have been suitably recognised by his colleagues on the Council.

Swindon.—The T.C. has given instructions for specifications to be prepared for the permanent way and overhead equipment of the new electric tramways, and also for cars.

Wolverhampton.—It would seem now as if the troubles of the Corporation with the Lorain Co. respecting the experimental tramlines are just commencing. It transpires that when the contract with the company was drawn up, the representatives of the Corporation responsible for it failed to recognise the necessity of stipulating that in case of arbitration proceedings, the trams should be available until the Corporation could make other arrangements for the traffic, or at any rate, until the termination of the arbitration proceedings. The consequence is this, that the Corporation is now practically at the mercy of the Lorain Co., and last week a rumour gained currency that the company were about to stop the cars running. Whatever the course, two meetings of the Tramways Committee, hurriedly convened, were held last week, but, as usual, it is difficult to ascertain what transpired. This, at any rate, may be definitely stated that whilst the discussion on the trams was proceeding in the Council, an arrangement was made with the Lorain Co. on terms to run the cars and supervise the working until the 16th of this month—that is really an extension of two, over the 12 months originally agreed upon. When the decision of the Council was communicated to the company, the representative of the latter immediately wrote to the Corporation asking that it might be pointed out to them in what respect they had failed to comply with the terms of the contract. The reply the company received was unsatisfactory, and thereupon they gave notice of their intention to proceed to arbitration. But the important question for the travelling public is, what is to be done after June 16th, and while the arbitration is proceeding? The Lorain Co., it is stated, have indicated to the Corporation that they will take no further part in supervising the system, that they will supply no defects, and give no advice—that, in short, they will stand aside and leave the officials of the Corporation to run the system and cope with whatever incidents or defects may arise.

"ELECTRICAL REVIEW" LIST OF ELECT

Place.	Supply Authority.	Year of opening	Engineer.	Pressure of supply, volts.	Frequency and Phase.	Boilers and Auxiliaries.	Engines.	Generators.
PROVINCIAL.								
1 ABERDEEN	Corporation	1894	J. Alex. Bell	220 & 440	Direct	8 B. & W., 2 suphtrs. (Cotton St.). 6 B. & W., suphtrs., ch. g. stokers, surf. cond., (Dee Village).	6 Willans, 1 Belliss 7 Willans, all vert. comp.	5 E.C.C., 2 Holmes, 1 Crom 1 Mather & Platt 1 J. Lundell, 2 Mavor & Cou 1 Westinghouse, 1 Peebles
2 ABERYSTWYTH	A. & Chiswick Elec. S. Corpn., Ltd.	1895	W. L. Knight	100 & 220	100~, 1-ph., & direct	3 Paxman Economic	4 Browett-Lindley, vert. comp., 2 Peache	2 Johnson & Phillips, A. C., 2 P. D. C., 2 Brush arc.
3 ACCRINGTON	Corporation	1900	H. Gray	230	Direct	3 Lanc., econ , jet cond. ; Horsfall destr.	3 Willans, 2 Browett-Lindley	3 J. & P., 2 Lancs. Dyn Co.
4 ALDERLEY EDGE	A. & Wilmslow El. Supply Co. Ltd.	1899	C. W. Bentley	210	Direct	2 loco. (Paxman)	2 Belliss	2 Edison-Swan
5 ALDERSHOT	Urban District Council	1903	F. J. Robins	210 & 420	Direct	3 B. & W., econ., surf. cond.	4 Willans	4 Parker
6 ALLOA	Corporation	1902	A. Yuill	220 & 440	Direct			
7 ALNWICK	Northern Counties Elec. Supply Co.	1902	C. S. Vesey Brown C. W. Fairweather	230 & 460	Direct	2 B. & W., stokers and econ.	2 Ruston Proctor	2 Crompton
8 ALTRINCHAM	A. Elec. Supply Co., Ltd.	1895	H. C. Caldwell	100	80~, 1-ph.	6 Lanc. (4 Meldrum furn., 2 w. stokers), ejector cond., and econ.	5 Browett-Lindley, vert. comp.	5 Edison & Swan
9 ASHTON-U-LYNE	Corporation	1899	N. Appelbee	240 & 480	Direct	4 Lanc., 2 tubular, econ., surf. cond.	3 Browett-Lindley, 2 Belliss, all vert. comp.	3 Jackson (Sayers), 3 Siemens
10 ATHERTON	Urban District Council		T. L. Miller (Cons. Eng.)	230	50~, 2-ph.			
11 AYR	Corporation	1893	Roland Marshall	200 & 250	60~, 1-ph., & direct	4 Lanc., 2 Stirling, Vicars and chain grate stokers	8 Belliss vert., 1 Marshall hor.	4 Siemens A. C., 1 Siemen Peebles D. C.
12 BANBURY	B. & Dist. Electric Supply Co.	1902	G. Charlton	230 & 460	Direct	2 B. & W.	3 Steam turbines	
13 BANGOR (WALES)	Corporation	1900	P. F. White	200 & 400	Direct	2 Hornsby watertube, Meldrum destr.	3 Willans	2 Fowler, 1 J. P. Hall
14 BARKING	Urban District Council	1899	A. H. Seabrook	230 & 460	Direct	4 B. & W., motor pumps and cond., clg. tr.	2 S. Forge, 3 Allen, all vert comp.	2 S. Forge, 2 Thames Ironwo 1 Siemens
15 BARNES	Urban District Council	1901	C. S. Davidson	210 & 420	Direct	3 B. & W., surf. cond., fd. htr.	4 Belliss (2 triple, 2 comp.)	4 Siemens
16 BARNSLEY	Corporation	1900	S. E. Bastow	230	Direct	5 Lanc., stokers, surf. cond., econ.	5 Willans	4 J. & P., 1 Peebles
17 BARNSTAPLE	Corporation	1903	J. W. Hadfield	230 & 460	Direct	3 B. & W., suphtrs., econ., surf. cond.	3 Reavell 3-crank compound	3 Newton Electrical Co.
18 BARROW-IN-FURNESS	Corporation	1899	H. R. Burnett	220 & 440	Direct	4 B. & W., econ., surf. cond.	3 Universal, 2 Willans	3 Brush, 2 Peebles
19 BATH	Corporation	1890	F. Teague	100, 200 & 220	100~, 1-ph. & direct	4 B. & W.	2 Pollitt & Wigzell, 4 Brush (marine) all vert. comp , 2 Belliss	2 E. C. C., 4 Mordey (rope driver 2 D. Kerr
20 BATLEY	Corporation	1903	S. W. Jones	220 & 440	Direct	3 Lanc., Proctor stokers, econ., jet cond., clg. tr.	3 Belliss & Morcom	3 Fowler
21 BECKENHAM	Urban District Council	1900	A. J. Hedgcock	200 & 400	50~, 1-ph.	4 B. & W., suphtrs., econ., heater detartariser	3 Belliss, 1 Browett-Lindley	3 Fowler, 1 Johnson & Phillips
22 BEDFORD	Corporation	1894	R. W. L. Phillips	105 & 210	60~, 1 ph.	7 B. & W., 2 Lanc., stokers, surf. cond.	2 Bellis, vert. comp., 5 Allen	1 Johnson & Phillips, 2 Siem 3 Fynn
23 BELFAST	Corporation	1895	V.A.H McCowen	220 & 440	Direct	6 Lanc., 4 B. & W., stokers, econ., feed htrs., surf. cond., clg. tr.	Belliss, 8 vert. comp., 2 vert. triple	6 Parker, 5 M. & P., 1 J. & P.
24 BEXHILL-ON-SEA	Corporation	1903	W. T. Le Feuvre	220 & 440	Direct	2 Hornsby, 1 B. & W., suphtrs., surf. cond., clg. tr.	3 Allen vert. comp.	3 Allen
25 BIRKENHEAD	Corporation	1896	W. Bates	230 & 460	Direct	3 Lanc., Vicars stokers, econ.; 2 B. & W., ch. grate stokers	7 Willans	3 Crompton, 2 Siemens, 2 Mavo Coulson
26 BIRMINCHAM	Corporation	1891	J. C. Vaudrey	220 & 440	Direct	20 Lanc., 4 B. & W.	13 Willans, 9 Belliss	4 M. & P., 13 Crompton, 5 E. C.
27 BLACKBURN	Corporation	1895	A. S. Giles	110, 220, & 440	50~, 1-ph., & direct	8 Lanc., stokers, econ., part surf. cond.	5 Willans, 7 Belliss	1 M. & P., 7 Siemens, 3 Mavo Coulson, 1 E. C. C.
28 BLACKPOOL	Corporation	1898	Charles Furness	200	83~, 1-ph., & direct	5 Lanc., 2 marine, 5 B. & W.	5 Fowler hor. comp. (ropes), 1 Ferranti vert. comp. 8 Parsons	8 Parsons, 3 Fowler, 2 E. C. C Ferranti
29 BLYTH & COWPEN	Northern Counties Elec. Supply Co.	1901	C. S. Vesey Brown, C. W. Fairweather	230 & 460	Direct	2 B. & W., econ.	2 Allen	2 Crompton
30 BOLTON	Corporation	1894	A. A. Day	100 & 200a.c. 230 & 460 d.c.	83~, 1-ph., & direct	13 Lanc., stokers, suphtrs., jet cond., clg. tr., econ.	6 Musgrave, cond., 4 Hick Hargreaves, non-cond., 1 Wood (rope dr.), all vert. comp.	1 English Elec. Mfg. Co., 4 Mat & Platt, D.C., 4 Ferranti, 1 Mord A.C.
31 BOOTLE	Corporation	1899	T. D. Clothier	220, 440, & 500	Direct	4 Lanc., stokers, econ., ejector cond.	6 Belliss (5 compound, 1 triple)	5 Parker, 1 E. C. C.
32 BOURNEMOUTH	B. and Poole Electricity Supply Co.	1891	E. L. Ingram	100 & 200	100~, 1-ph.	11 B. & W., cond., cooler, suphtrs.	1 Brush, vert. comp.	9 Mordey A.C., 2 Brush D.C.
33 BRADFORD	Corporation	1899	R. A. Chattock	230 & 460	Direct	4 Lanc., 6 marine, ind. draught stokers, 10 watertube, econ. Total 20 suphtrs., econ., cond. clg. tr.	18 Willans, 1 Marshall & 2 Cole, Marchent & Morley. Total 21	15 Siemens, 2 E. C. C., 2 Peebl 2 Westinghouse. Total, 21
34 BRAY	Urban District Council	1892	A. E. Wilkins	100	60~, 1-ph.	1 loco., 1 Lanc., cond., econ.	1 Brush, 1 Easton-Anderson, 1 Victor turbine	1 Mordey, 2 International
35 BRECHIN	Angus Electric Lt. & Pr. Co.	1901	H. Dixon	240 & 480	Direct	2 B. & W., suphtr., feed htr.	2 Belliss	2 Parker
36 BRICHOUSE	Corporation	1897	A. Aspinall	110	Direct		3 Crossley gas	3 Brook
37 BRICHTON	Corporation	1891	J. Christie	115, 230, & 460	Direct	6 Lanc., 10 B. & W.	15 Willans	2 Goolden, 2 Siemens, 3 Crompt 3 Peebles, 8 E. C. C.
38 BRISTOL	Corporation	1893	H. Faraday Proctor	105, 210, 250 & 500	93~, 1-ph. & direct	Temple Back:—12 Lanc., 2 B. & W., stokers, surf. cond. Avonbank:—4 B. & W., stokers, suphtrs., surf. cond.	15 Willans comp., 1 Parsons turbine 4 Willans triple	13 Siemens, 1 Ferranti, 1 Siem turbo. dynamo, 1 Dick Kerr 4 Siemens
39 BROMLEY (KENT)	Bromley (Kent) Elec. Lt. & Pr. Co.	1898	R. L. Gamlen	210	Direct	4 Paxman economic, surf. cond.	6 Bellias	6 Parker
40 BROUGHTY FERRY	Corporation	1902	Forbes Waddell	230 & 460	Direct	2 B. & W., cond.	2 Belliss	2 Parker
41 BUCKINGHAM	B. Electric Lt. & Pr. Supply Co.	1889		100	Direct	1 Cochrane marine vertical, 1 Marshall loco.	1 hor. Brown & May, 1 Marshall semi-portable	1 Greenwood & Batley, 2 Elwe Parker, 1 Goolden
42 BURNLEY	Corporation	1893	R. Birkett	110, 220, & 440	Direct	5 Lanc., stokers and econ.	3 Burnley Iron Works hor. comp., 2 Belliss vert. comp.	5 E.C.C.
43 BURTON-ON-TRENT	Corporation	1894	F. L. Ramsden	100 & 200	75~, 1-ph.	6 Lanc., econ., ejector and jet cond.	3 Fowler hor., 1 Alley - Maclellan vertical	3 Fowler, 1 Brown-Boveri
44 BURY	Corporation	1836	S. J. Watson	220 & 440	Direct	3 Lanc., econ., cond.	4 Belliss	4 Siemens
45 BURY ST. EDMUNDS	Corporation	1900	L. P. Greig	200 & 400	Direct	2 Lanc. detart., econ.	2 Belliss	2 Fowler
46 BUXTON	Urban District Council	1900	W. J. Leaming	230	Direct	6 Hornsby w.t., jet cond.	6 Belliss	6 M. & P., 2 Sunderland For 1 E. C. C.
47 CAMBORNE, REDRUTH AND ILLOGAN	Urban Electric Supply Co.	1902	F. S. Hannay	240 & 480		2 Lanc.	4 Belliss	5 Parker
48 CAMBRIDGE	Cambridge Elec. Supply Co.	1892	H. B. Harvey	100 & 200	90~, 1-ph.	4 Lanc. econ.	7 Parsons turbines	7 Parsons
49 CANTERBURY	Corporation	1899	C. A. Blascheck	220	Direct	4 Lanc., stokers, econ., ejector and surf. cond.	4 Belliss	6 Silvertown, 2 Johnson & Phill
50 CARDIFF	Corporation	1894	Arthur Ellis	100, 200 & 400	40~, 1-ph.	5 dryback, 3 B. & W., suphtrs., jet and surf. cond.	2 Paxman triple, 2 Belliss comp., 1 Ferranti vert. comp.	4 Siemens, 1 Ferranti
51 CARLISLE	Corporation	1899	C. D. Burnet	230 & 460	Direct	5 Lanc., stokers, econ., eject cond.	6 Willans	2 Peebles, 6 Siemens
52 CARLOW	J. Alexander	1890	G. Marshall Harris	100 & 200	70~, 1-ph., & direct	1 B. & W.	1 Belliss, 2 Waverley, 1 Vortex, turbines (water)	2 E. C. C., A. C.; 3 Laurence Sco D.C.
53 CHACFORD	C. & Devon Electric Light Co.	1901	G. H. Reed	100	93~, 1-ph.		Water-wheel	2 Siemens
54 CHATHAM AND ROCHESTER	C., B. & District Elec. Ltg. Co.	1888	C. T. Linney	100 & 200	100~, 1-ph.	1 Lanc., 3 B. & W., cond., clg. tr.	3 Marshall, 1 Robey, 1 Parsons	2 Mordey, 2 Ferranti, 1 Parsons
55 CHELMSFORD	C. Electric Lighting Co.	1890	A. H. French	100 & 200	100~, 1-ph., & direct	2 Lanc., 2 B. & W., chain grate stokers	6 Willans, 2 Peache	10 Crompton
56 CHELTENHAM	Corporation	1895	M. H. Kilgour	100 & 200	100~, 1-ph., & direct	1 Lanc., 6 B. & W., and econ.	3 Willans, 4 Belliss, 2 Parsons turbines	5 Siemens (2 D.C., 3 A.C.), 2 Parso A.C., 2 Witting Bros. D.C.
57 CHESTER	Corporation	1893	F. Thursfield	210	Direct	7 B. & W., stokers	6 Belliss	6 Parker
58 CHESTERFIELD	Corporation	1901	R. L. Acland	240 & 480	Direct	5 B. & W., econ.	4 Belliss	4 Westinghouse
59 CHISLEHURST	Chislehurst Electric Supply Co.	1899	R. L. Gamlen	210	Direct			2 Parker motor transformers
60 CHISWICK	Aberystwith & C. Elec. Supply Corp.	1901	A. W. Money	220 & 440	Direct	3 Economic, forced draught	3 Peache, vert. compound	3 Johnson & Phillips
61 CLECKHEATON	Urban District Council	1902	A. Pickersgill	230 & 460	Direct	4 Lanc. (2 fired by Meldrum destructor)	3 Belliss	3 Johnson Lundell
62 COATBRIDGE AND AIRDRIE	Scottish H. to H. Electric Co.	1894	R. S. Draycott	240 & 480	Direct	3 Lanc., Vicars stokers, surf. cond.	2 Browett-Lindley, 2 Belliss-Morcom	2 Brush, 2 Mavor & Coulson

CTRICITY SUPPLY WORKS OF THE UNITED K

nerators.	Total Capacity in KW.	Max. load recorded in KW.	Battery Capacity and Output.	Mains.	Total capital expended.	Private supply, eqvt. 8 c.p. lamps.	Lamps added during year.	Public lighting.	No. and H.P. of motors.	Price charged per unit.	System of charging.	Units sold during year.	Pence Per Unit Sold: Av. price obtained.	Works cost	To
olmes, 1 Crompton, latt	760	1,557	E.P.S., 20 KW. for 10 hrs.	Bare copper, bit. paper and jute in Crompton Davies casing, iron pipes, wdn. troughing, solid	£167,173	101,473	31,810	235 arc ..	216=288 H.P.	Ltg. 6d. & 2½d., pr. 3d. & 1d.	Max. demand	1,546,569	3.52	1.1	
Mavor & Coulson, se, 1 Peebles	1,680		E.P.S., 90 KW. for 10 hrs.												
hillips, A. C., 2 J. & sh arc.	240	140	.. ..	Armd. and lead covd. conc., B.I.W.	..	9,795	1,371	29 arc, 1 inc.	..	6d.	Flat rate ..	..	..	..	
cs. Dyn Co. ..	518	194	Chloride, 70 KW. for 5 hrs. ..	Single core ppr., feeders solid dist. direct	£42,516	16,800	6,350	9 arc, 32 inc.	25=129 H.P.	Ltg. 5d. & 3d., pr. 4d. & 1½d.	Max. demand*	175,890	3.77	1.218	
.. .. ..	92	43	D-P., 240 KW. hrs.	Triple conc. fdrs., 3-core dist., both armd. and lead covd., Callender	£22,649	6,396	1.715	..	1=2 H.P. ..	7d. & 4d.	Max. demand	44,562	6	..	
.. .. ..	*470	180	300 amp.-hrs.	Callender feeders and distributors, laid solid	£25,000	8,000	..	16 arc, 25 inc.	7=15 H.P. ..	Ltg. 6d. & 4d., pr. 3d. & 2d.	Max. demand	Contract for	with Messrs. first year's	Thos. Parker running.	Ltd
.. .. ..	..	..	.. ..	Fdrs. 3-core dist. single, v. bit., Callender, solid ..	£9,500	2,800	..	20 arc ..	3=2 H.P. ..	Ltg. 7d. & 3d., pr. 7d. & 2d.	Max. demand	..	..	..	
.. .. ..	150	..	Chloride 250 amp.-hrs. ..	Callender, single, solid, in wood	£12,000	..	..	..	..	..	..	..	..	..	
n	600	399	.. ..	Fdrs. v.r. conc., dist. armd. dia. and ppr.	£59,192	38,676	4,442	..	2=15 H.P...	Ltg. 6d., pr. 3d. ..	Flat rate ..	..	..	..	
s), 3 Siemens ..	1,260	700	.. ..	Conc. paper and bitumen	£50,000	..	..	72 arc, 144 inc.	600 H.P.* ..	Under revision ..	Under revision	..	..	..	
.. ..	..	..	.. ..	Callender, conc., ppr. ins. bit. solid in wood troughs ..	£10,000	2,300	..	..	185	Ltg. 5d., pr. 1½d...	Flat rate ..	..	..	..	
c., 1 Siemens, 2	1,150	548	E. P. S., 30 KW. for 7 hrs. ..	A.C., conc. armd. ; D.C., bit. solid, Callender	£82,000	23,200	1,200	159 arc, 150 inc.	6=24 H.P. ..	Ltg. 5d., pr. 2d. tr. 1½d. & 1d.*	Flat rate ..	..	..	..	
.. .. ..	..	..	.. ..	Callender, laid solid, fdrs. conc., dist. 3-core	..	..	..	..	..	Ltg. 7d. & 2½d., pr. 4½d. to 1½d.	Max. demand	..	..	..	
Hall	290	175	Chloride, 35 KW. for 6 hrs. ..	Ppr., lead covd., armd. B.I.W.	£22,682	8,265	1,439	..	4=13 H.P. ..	Ltg. 5d., pr. 2½d...	Flat rate ..	97,771	5	2.94	
Thames Ironworks,	610	250	.. ..	Callender, fdrs. in c.w. casing, dist. do and solid* ..	abt. £40,000	14,564	3,443	1594.. ..	30=164 H.P.	Ltg. 4½d., pr. 3½d. & 1½d.	Ltg. flat rate, pr. sldg. sc.	394,624	3.37	1.55	
.. .. ..	470	115	E. P. S., 25 KW. for 7 hrs. ..	Jute, lead covd.; armd. direct, unarmd., in Sykes conduit ; Callender	£35,268	10,262	Private 3,878	725-8cp. ½amp) Nernst.	1=5 H.P. ..	Ltg. 5d., pr. 3d. ..	Flat rate disc.	123,379	4.30	1.30	
es	675	..	Pritchetts & Gold, 50 KW. for 6 hrs., & E.P.S. Trac. Battery	Ppr. lead covd., solid, also armd. B.I.W...	£54,453	31,171	3,000	33 arc, 85 inc.	61=306 H.P.	Ltg. 7d. & 2d., or 4d., pr. 1½d.*	Max. dem. & flat rate	556,923	2.81	.92	
cal Co.	375	125	Ashmore - Benson - Pease, 400 KW. hrs.	Dialite, laid solid in wood. St. Helens Cable Co. ..	..	4,200	..	8 arc, 21 Nernst	3 H.P. ..	Ltg. 6d., pr. 3d. ..	Flat rate ..	..	..	..	
s	525	441	Tudor, 30 KW. for 5 hrs. ..	Ppr. conc., B.I.W.	£67,373	34,829	12,267	48 arc, 57 inc.	56=312 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1½d.	Max. demand	403,395	4.17	1.58	
dey (rope driven) &	1,500	785	.. ..	V. bit single, solid, for h.p. ; conc. fibre armd. for l.p. ; Callender	£103,428	43,604	10,587	182 arc ..	..	Ltg. 5d., 4½d. & 4d. pr. 2½d.	Flat rate & dis.	878,400	3.87	1.67	
.. .. ..	450	..	400 amp.-hrs.	Callender, 3-core ppr., in Howard trg.	..	..	..	24 arc ..	..	6d. & 3d.	Max. demand	..	..	..	
on & Phillips ..	550	217	.. ..	Conc., ppr., lead covd., B.I.W.	£67,000	20,447	2,472	17 arc, 32 inc.	5=13 H.P...	Ltg. 6d., less 10 % pr. 2d. *	Flat rate ..	261,686	5½ private 3 public	2.25	
illips, 2 Siemens,	860	560	.. ..	V. r. in ducts, and ppr. B.I.W., 2 and 3-core	£94,204	41,692	4,347	3 arc., 564 inc.	22=92 H.P.	Ltg. 5½d., pr. 2d...	Flat rate ..	756,470	4.19	1.93	
P., 1 J. & P. ..	3,030	1,968	E. P. S., 90 KW. for 4 hrs. ..	Single vulc. bit., solid, and drawn into c.i. and e'ware pipes	£221,718	122,000	24,000	60 inc. ..	1,360 H.P. ..	Ltd. 6d. & 2d.. pr. 3d. and 1d.	Max. demand	1,665,560	3.179	0.916	
.. .. ..	350	250	Chloride, 50 KW. for 5 hrs. ..	Fdrs. triple conc. ; dist. 3-core, ppr., lead covd., and armd. ; B.I.W.	£33,000	11,500	9,000	41 arc, 332 inc.	9=26 H.P...	7d. & 3d.	Max. demand	..	..	..	
emens, 2 Mavor &	900	459	60 KW. for 7 hrs.	Fibre and ppr. ins., lead covd., fdrs., laid solid, dist. armd., and laid direct	..	40,100	9,008	54 arc ..	28=615 H.P.	Ltg. 6d., 3d., & 1½d., pr. 2½d. to 1½d.	Max. demand & sldg. scale	547,638	..	..	
mpton, 5 E. C. C..	4,760	4,200	E. P. S.	Callender, solid	£588,323	201,300	28,300	..	402=1,150 H.P.	Ltg. 6d. & 4d., pr. 3d., 2d. & 1½d.	Sliding scale	3,737,419	4.15	1.46	
emens, 3 Mavor & . C.	2,300	1,406	E. P. S., 100 KW. for 3 hrs. ..	V.r. on insrs., in c.i conduits ; v.r. conc. armd. in c.i. pipes, Siemens & Glover	£117,000	60,000	10,578	80 arc, 248 inc.	94=280 H.P.	Ltg. 6d. & 3d., pr. 2½d. & 1½d.	Max. demand	..	..	.	
ler, 2 E. C. C., 1	3,050	1,730	Hart, 80 KW. for 5 hrs. ..	H.p. twin, l.p. conc. and single, ppr., solid, B.I.W. and St. Helens	£173,000	47,472	4,203	263 arc, 290 inc.	28=128 H.P.	Ltg. 7d. & 2d., pr. 2½d., tr. 2d. to 1½d.	Max. demand	2,169,463	4.1	1.52	
.. .. ..	400	..	Chloride, 40 KW. for 5 hrs. ..	Callender, single cables laid solid	£25,000	..	..	..	..	Ltg. 5½d. to 4d., pr. 2½d. to 1½d.	Sliding scale	..	..	..	
Mfg. Co., 4 Mather Ferranti, 1 Mordey,	3,900	2,300	.. ..	H.p. conc. v.r. and ppr., ld. covd. in pipes or armd.; l.p., fdrs., tr. conc. ld. covd. solid, dist., 3-core, ld. covd., solid, or 3 single, ld. covd., armd.	£207,482	116,323	23,266	8 arc ..	144=925 H.P.	Ltg. 6d. & 3d. or 5d., pr. 2½d., 1½d. ld., tr. 1·4d.	Max. demand & flat rate	3,802,598	2.02	.662	
C.	850	650	Chloride, 132 KW. for 6 hrs...	Ppr. lead covd ; B.I.W. ; vulc. bit., Callender, solid, and St. Helens Dialite	£72,454	30,553	..	166 arc, 1,451 equiv. 8 c.p.	282 ¾ H.P. ..	Ltg. 5d. & 3d., pr. 2d. to 1d.	Max. demand	1,619,129	1.92	.7	
Brush D.C. ..	1,930	1,282	One 90 amp.-hrs., one 270 amp-hrs.	Armd and unarmd., v.r., fibre and ppr. lead. covd. ..	£231,456	79,309	18,247	..	19=55 H.P.	Ltg. 7d. & 3½d., pr. 3d.	Max. demand	1,260,366	5.07	..	
. C. C., 2 Peebles, . Total, 21	6,380	4,977	E. P. S., 400 KW. for 6 hrs ..	Ppr. lead covd., armd., also solid for fdrs.	£429,768	239,509	32,333	51 arc ..	913=4,398 H.P.	Ltg. 4½d., pr. 2d. & 1d., tr. 1d.	Flat rates ..	9,124,228	1.742	.524	
national	175	52	.. ..	Ppr, lead covd. conc. B.I.W., direct	£10,000	5,621	297	30 arc, 200 inc.	..	6d. & 3½d.	Max. demand & contract	135,057	3½	1.7	
.. .. ..	182	91.4	D. P., 300 amp.-hrs.	Fdrs. conc., dist. 3-core, Callender..	..	6,295	..	101 inc. ..	6=27 H.P...	Ltg. 6d. & 4d. or 5½d., pr. 4d. & 1½d., or 2½d.	Max. demand & flat rate	..	..	..	
.. .. ..	40	..	Chloride, 400 amp.-hrs. ..	Overhead Glover	£2,258	4,800	400	..	9=24 H.P. ..	Ltg. 6d., pr. 5d. ..	Flat rate ..	..	..	..	
hens, 3 Crompton, C. C.	6,185	4,534	Tudor, 400 amp.-hrs., lighting. E. P. S., 1,200 amp-hrs., tr.	Triple conc. and single, armd. direct, and solid.. ..	£339,602	193,000	37,000	367 arc, 2,500 inc.	135=600 H.P.	Ltg. 7d. & 1d., tr. 1½d.	Max. demand & flat rate	..	..	..	
rranti, 1 Siemens 1 Dick Kerr	3,216	2,831	E. P. S., 1,500 amp.-hrs. ..	Jute and ppr. Siemens. ppr. B.I.W., conc., lead covd. armd. direct	£453,290	Ltg. 144,866 prdt 32,027	20,481 12,507	310 arc, 10 inc.	262=1,288 H.P.	Ltg. 5d., pr. 1½d...	Flat rate with discount	3,409,758	3.44	1.20	
.. .. ..	1,820														
.. .. ..	800	380	Pritchetts & Gold, 40 KW. for 10 hrs.	Fdrs. triple conc., dist. 3-core, Callender	£81,725	27,414	7,189	..	20=155 H.P.	Ltg. 7d. & 4d., pr. 4d. & 1d.	Max. demand	419,000	4.7	1.45	
.. .. ..	100	35	450 amp-hrs.	Callender, single, laid solid..	£13,000	5,171	..	12 arc, 36 inc.	5=20 H.P...	Ltg. 6d., pr. 4d. ..	Flat rate ..	39,707	..	..	
Batley, 2 Elwell- en	60	..	E. P. S., 3 sets, 9 KW. for 10 hrs.	Overhead	..	1,300	..	10 inc ..	..	8d.	Flat rate ..	..	..	..	
.. .. ..	1,030	590	Tudor, ltg. 300 KW. for 1 hr., traction 250 KW. for 1 hr	Armd. and solid Callender, solid, B.I.W...	£74,000	28,066	2,500	3 arc, 12 inc.	37=64 H.P.	Ltg. 4d., pr. 3d.-2d.	Flat rate ..	..	..	..	
-Boveri	800	318	.. ..	H.p., B.I.W. ; l.p., Silvertown and B.I.W., part solid, part iron pipes for both	..	22,603	3,482	..	12=65 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d., or 2d. to 1½d.	Max. demand & sldg. scale	251,982	4.9	..	
.. .. ..	760	320	E. P. S., 46 KW. for 7 hrs. ..	V.r. and v. bit. in c.i. and stoneware pipes and solid ..	£59,323	35,647	10,979	34 arc, 17 inc.	74=457 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d.	Max. demand	424,993	3.42	1.68	
.. .. ..	132	118	E. P. S., 500 amp.-hrs. ..	Callender	£24,853	4,827	2,327	14 arc, 400 inc.	13=84·5 H.P.	Ltg. 6d., pr. 3d. to 2½d.	Flat rate ..	170,359*	3.09	1.9	
underland Forge,	538	202.5	Tudor, 250 amp.-hrs.	Conc., jute, lead covd. and armd . laid direct, Callender	£41,530	14,905	2,934	30	16=40 H.P.	6d., 4d. & 3d. or 7d. & 3d.	Sliding sc., or max. dem.	146,480	5.22	2.5	
.. .. ..	425	..	Two 210 amp.-hrs. for ltg., One 300 amp.-hrs., tr.	Callender, laid solid, and armd.	Incomplete	4,600	1,000	635 8. c.p. equiv.	6=60 H.P...	Ltg. 7d. & 4d., pr. 4d. & 1½d., tr. 1½d.	Max. demand	112,761*	1.9*	.96*	
.. .. ..	1,500	524	.. ..	H.p. v.r. Silvertown, ppr. B.I.W., l.p. v r., B.I.W., Glover & Henley ppr. c.nc., single and twin	£78,166	38,556	3,833	1 arc ..	10=32 H.P.	7d.	Flat rate with disc.	431,379	5.90	1.57	
hnson & Phillips	600	293	Chloride, 150 KW. for 5 hrs...	Western Elec. triple conc. armd., also Siemens & Henley	£52,248	17,363	3,859	12 arc, 415 inc.	23=40 H.P.	7d. & 3d. or 6d. ..	Max. demand or flat rate	345,286	4.3	1.55	
nti	1,260	1,372	.. . .	V.r. conc., ppr, armd., Siemens	£157,223	78,300	32,050	224 arc, 98 inc.	67=458 H.P.	Ltg. 7d. & 2d. or 4½ l., pr. 4d. & 1d.	Max. demand flat rate, & ppt.	1,492,470	3.40	..	
ns	870	488*	Chloride, 27.6 KW. for 5 hrs	Callender, conc. v. bit. lead covd. armd. B.W. single direct and solid	£51,550	18,717	2,347	45 arc, 20 inc.	..	Ltg. 5d. 4½d. & 4½d. pr. 2d., tr. 2d. 1½d.	Rebate ..	541,430	..	1.65	
3 Laurence Scott,	115	..	Chloride, 40 KW. for 4 hrs. ..	Ppr. in ducts and covd. overhead, h.p. (5 miles), l.p. covd. overhead	..	..	400	13 arc, 80 inc.	1=67 H.P...	6d. & 3½d.	Discounts ..	..	..	..	
.. .. ..	22	19	.. ..	Ppr., lead covd., B.I.W.	..	..	..	16 inc. ..	..	6d.	Flat rate ..	..	..	..	
nti, 1 Parsons ..	900	337	.. ..	Brooks semi-solid, Glover & Henley armd. conc	..	16,017	3,286	..	2=12 H.P...	Ltg. 7d. & 4d. or 5d., pr. 3d.	Max. demand or flat rate	..	..	..	
.. .. ..	605	281	Chloride, 36 KW. hrs... ..	H.p. ppr. conc., dist. v.r. and ppr.	£51,353	16,035	648	21 arc, 272 inc.	28=113 H.P.	Ltg. 6½d., pr. 3d...	Flat rate ..	399,690	3.96	2.05	
3 A.C.), 2 Parsons Bros. D.C.	1,700	750	Tudor, 60 KW. for 3 hrs. ..	Bit. fibre, Callender	£133,062	34,556	6,879	331 arc, 19 inc.	7=40 H.P...	Ltg. 6d. & 3½d. pr. 3d. tr. 1·9 to 1d.	Max. demand	..	..	..	
.. .. ..	1,000	728	E. P. S., 21 KW. for 5 hrs., & Tudor 125 K.W. for 1 hr.	Bit. fibre, lead covd. and armd., Callender	£83,542	41,264	5,913	173 arc, 891 inc.	175 H.P. ..	Ltg. 4d., pr. 2½d. to 1½d.	Flat rate with discount	214,644	..	..	
.. .. ..	600	291	Chloride, 600 amp.-hrs ..	Conc. solid throughout, B.I.W.	£55,000	16,000	7,000	20 arc, 40 inc.	20=146 H.P.	Ltg. 6d. & 3d., pr. 1½d.	Max. demand	209,000	4.6	.81	
nsformers ..	80	50	D. P., 20 KW. for 5 hrs. ..	Fdrs. triple conc., dist. 3-core, Callender..	£20,000	6,600	1,700	..	..	8d. & 4d.	Max. demand	..	..	..	
ips	498	300	Tudor, 45 KW. for 3 hrs. ..	Fdrs. drawn in, dist. solid, B I.W., T.C.C.	..	11,155	3,555	..	34=277 H.P.	Ltg. 5d., pr. 2½d. & 2d.	Flat rate ..	299,021	3.5	1.829	
1	450	150	50 amps. for 10 hrs.	B.I.W. laid solid in wood troughs..	£21,093	1,310*	..	3 arc ..	3=8 H.P. ..	Ltg. 5d., pr. 2d. ..	Flat rate with disc.	..	4.75	..	
& Coulson ..	800	150	Tudor, 480 amp.-hrs.	Fdrs. three single, dist., triple conc. Callender	..	10,200	2,740	22 arc, 214 inc.	22½	Ltg. 5d., pr. 2½d.*	Flat rate ..	..	..	..	

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REVIEW" LIST OF ELECTRICITY SUPPLY WOR

		Pressure of supply, volts.	Frequency and Phase.	Boilers and Auxiliaries.	Engines.	Generators.	Total Capacity in KW.	Max. load recorded in KW.	Battery Capacity and Output.	Mains.	Total capita expend
..		220 & 440	Direct	8 B. & W., 2 suphtrs. (Cotton St.).	6 Willans, 1 Belliss	5 E.C.C., 2 Holmes, 1 Crompton, 1 Mather & Platt	760	1,557	E.P.S., 20 KW. for 10 hrs.	Bare copper, bit. paper and jute in Crompton Davies casing, iron pipes, wdn. troughing, solid	£167,17
				6 B. & W., suphtrs., ch. g. stokers, surf. cond., (Dee Village).	7 Willans, all vert. comp.	1 J. Lundell, 2 Mavor & Coulson, 1 Westinghouse, 1 Peebles	1,680		E.P.S., 90 KW. for 10 hrs.		
t ..		100 & 220	100~, 1-ph., & direct	3 Paxman Economic	4 Browett-Lindley, vert. comp., 2 Peache	2 Johnson & Phillips, A. C., 2 J. & P. D. C., 2 Brush arc.	240	140	.. ..	Armd. and lead covd. conc., B.I.W.	..
..		230	Direct ..	3 Lanc., econ , jet cond.; Horsfall destr. ..	3 Willans, 2 Browett-Lindley ..	3 J. & P., 2 Lancs. Dyn Co. ..	518	194	Chloride, 70 KW. for 5 hrs. ..	Single core ppr., feeders solid dist. direct	£42,51
y ..		210	Direct ..	2 loco. (Paxman)	2 Belliss	2 Edison-Swan	92	43	D-P., 240 KW. hrs.	Triple conc. fdrs., 3-core dist., both armd. and lead covd., Callender	£22,64
..		210 & 420	Direct ..	3 B. & W., econ., surf. cond...	4 Willans	4 Parker	*470	180	300 amp.-hrs.	Callender feeders and distributors, laid solid	£25,00
..		220 & 440	Direct ..	.. ..	.. ..	.. ..	..	..	.. ..	Fdrs. 3-core dist. single, v. bit., Callender, solid ..	£9,50
rown		230 & 400	Direct ..	2 B. & W., stokers and econ.	2 Ruston Proctor	2 Crompton	150	..	Chloride 250 amp.-hrs. ..	Callender, single, solid, in wood	£12,00
ather ell ..		100	80~, 1-ph.	6 Lanc. (4 Meldrum furn., 2 w. stokers), ejector cond., and econ.	5 Browett-Lindley, vert. comp. ..	5 Edison & Swan	600	399	.. ..	Fdrs. v.r. conc., dist. armd. dia. and ppr.	£59,19
..		240 & 480	Direct ..	4 Lanc., 2 tubular, econ., surf. cond.	3 Browett-Lindley, 2 Belliss, all vert. comp.	3 Jackson (Sayers), 3 Siemens ..	1,260	700	.. ..	Conc. paper and bitumen	£50,00
..		230	50~, 2-ph.	.. ..	.. ..	.. ..	..	..	.. ..	Callender, conc., ppr. ins. bit. solid in wood troughs ..	£10,00
Eng.) hall		200 & 230	60~, 1-ph., & direct	4 Lanc., 2 Stirling, Vicars and chain grate stokers	8 Belliss vert., 1 Marshall hor. ..	4 Siemens A. C., 1 Siemens, 2 Peebles D. C.	1,150	548	E. P. S., 30 KW. for 7 hrs. ..	A.C., conc. armd.; D.C., bit. solid, Callender	£82,00
..		230 & 460	Direct ..	2 B. & W.	3 Steam turbines	.. ..	..	..	.. ..	Callender, laid solid, fdrs. conc., dist. 3-core	..
..		200 & 400	Direct ..	2 Hornsby watertube, Meldrum destr.	3 Willans	2 Fowler, 1 J. P. Hall	290	175	Chloride, 35 KW. for 6 hrs. ..	Ppr., lead covd., armd. B.I.W.	£22,68
ok ..		230 & 460	Direct ..	4 B. & W., motor pumps and cond., clg. tr. ..	2 S. Forge, 3 Allen, all vert comp.	2 S. Forge, 2 Thames Ironworks, 1 Siemens	610	250	.. ..	Callender, fdrs. in c.w. casing, dist. do and solid* ..	abt. £40,0
on ..		210 & 420	Direct ..	3 B. & W., surf. cond., fd. htr.	4 Belliss (2 triple, 2 comp.)	4 Siemens	470	115	E. P. S., 25 KW. for 7 hrs. ..	Jute, lead covd.; armd. direct, unarmd., in Sykes conduit; Callender	£35,268
..		230	Direct ..	5 Lanc., stokers, surf. cond., econ...	5 Willans	4 J. & P., 1 Peebles	675	..	Pritchetts & Gold, 50 KW. for 6 hrs., & E.P.S. Trac. Battery	Ppr. lead covd., solid, also armd. B.I.W.	£54,459
d ..		230 & 460	Direct ..	3 B. & W., suphtrs., econ., surf. cond.	3 Reavell 3-crank compound ..	3 Newton Electrical Co.	375	125	Ashmore - Benson - Pease, 400 KW. hrs.	Dialite, laid solid in wood. St. Helens Cable Co. ..	..
t ..		230 & 440	Direct ..	4 B. & W., econ., surf. cond.	3 Universal, 2 Willans	3 Brush, 2 Peebles	525	441	Tudor, 30 KW. for 5 hrs. ..	Ppr. conc., B.I.W.	£67,378
..		100, 200 & 220	100~, 1-ph. & direct	4 B. & W.	2 Pollitt & Wigzell, 4 Brush (marine) all vert. comp., 2 Belliss	2 E. C. C., 4 Mordey (rope driven) & 2 D. Kerr	1,500	785	.. ..	V. bit single, solid, for h.p.; conc. fibre armd. for l.p.; Callender	£103,428
..		220 & 440	Direct ..	3 Lanc., Proctor stokers, econ., jet cond., clg. tr.	3 Belliss & Morcom	3 Fowler..	450	..	400 amp.-hrs.	Callender, 3-core ppr., in Howard trg.	..
ck ..		200 & 400	50~, 1-ph.	4 B. & W., suphtrs., econ., heater detartariser ..	3 Belliss, 1 Browett-Lindley ..	3 Fowler, 1 Johnson & Phillips ..	550	217	.. ..	Conc., ppr., lead covd., B.I.W.	£67,000
llips		105 & 210	60~, 1 ph.	7 B. & W., 2 Lanc., stokers, surf. cond.	2 Bellis, vert. comp., 5 Allen ..	1 Johnson & Phillips, 2 Siemens, 3 Fynn	860	560	.. ..	V. r. in ducts, and ppr. B.I.W., 2 and 3-core	£94,204
wen		220 & 440	Direct ..	6 Lanc., 4 B. & W., stokers, econ., feed htrs., surf. cond., clg. tr.	Belliss, 8 vert. comp., 2 vert. triple..	6 Parker, 5 M. & P., 1 J. & P. ..	3,030	1,968	E. P. S., 90 KW. for 4 hrs. ..	Single vulc. bit., solid, and drawn into c.i. and e'ware pipes	£221,718
uvre		220 & 440	Direct ..	2 Hornsby, 1 B. & W., suphtrs., surf. cond., clg. tr.	3 Allen vert. comp.	3 Allen	350	250	Chloride, 50 KW. for 5 hrs. ..	Fdrs. triple conc.; dist. 3-core, ppr., lead covd., and armd.; B.I.W.	£33,000
..		230 & 460	Direct ..	3 Lanc., Vicars stokers, econ.; 2 B. & W., ch. grate stokers	7 Willans	3 Crompton, 2 Siemens, 2 Mavor & Coulson	900	459	60 KW. for 7 hrs.	Fibre and ppr. ins., lead covd., fdrs., laid solid, dist. armd., and laid direct	..
y ..		220 & 440	Direct ..	20 Lanc., 4 B. & W.	15 Willans, 9 Belliss	4 M. & P., 13 Crompton, 5 E. C. C..	4,760	4,200	E. P. S.	Callender, solid	£588,323
..		110, 220, & 440	50~, 1-ph., & direct	8 Lanc., stokers, econ., part surf. cond.	5 Willans, 7 Belliss	1 M. & P., 7 Siemens, 3 Mavor & Coulson, 1 E. C. C.	2,300	1,406	E. P. S., 100 KW. for 3 hrs. ..	V.r. on insrs., in c.i conduits; v.r. conc. armd. in c.i. pipes, Siemens & Glover	£117,000
ness		200	83~, 1-ph., & direct	5 Lanc., 2 marine, 5 B. & W.	5 Fowler hor. comp. (ropes), 1 Ferranti vert. comp. 8 Parsons	8 Parsons, 3 Fowler, 2 E. C. C., 1 Ferranti	3,050	1,730	Hart, 80 KW. for 5 hrs. ..	H.p. twin, l.p. conc. and single, ppr., solid, B.I.W. and St. Helens	£173,000
rown, ather		230 & 460	Direct ..	2 B. & W., econ.	2 Allen	2 Crompton	400	..	Chloride, 40 KW. for 5 hrs. ..	Callender, single cables laid solid	£25,000
..		100 & 200a.c. 230 & 460 d.c.	83~, 1-ph., & direct	13 Lanc., stokers, suphtrs., jet cond., clg. tr., econ.	6 Musgrave, cond., 4 Hick Hargreaves, non-cond., 1 Wood (rope dr.), all vert. comp.	1 English Elec. Mfg. Co., 4 Mather & Platt, D.C., 4 Ferranti, 1 Mordey, A.C.	3,900	2,800	.. ..	H.p. conc. v.r. and ppr., ld. covd. in pipes or armd.; l.p., fdrs., tr. conc. ld. covd. solid, dist., 3-core, ld. covd., solid, or 3 single, ld. covd., armd.	£207,482
er ..		220, 440, & 500	Direct ..	4 Lanc., stokers, econ., ejector cond.	6 Belliss (5 compound, 1 triple) ..	5 Parker, 1 E. C. C.	850	650	Chloride, 132 KW. for 6 hrs...	Ppr. lead covd, B.I.W.; vulc. bit., Callender, solid, and St. Helens Dialite	£72,454
n ..		100 & 200	100~, 1-ph.	11 B. & W., cond., cooler, suphtrs.	11 Brush, vert. comp.	9 Mordey A.C., 2 Brush D.C. ..	1,930	1,282	One 90 amp.-hrs., one 270 amp-hrs.	Armd. and unarmd., v.r., fibre and ppr. lead. covd. ..	£231,456
ck ..		230 & 460	Direct ..	4 Lanc., 6 marine, ind. draught stokers, 10 water-tube, econ. Total 20 suphtrs., econ., cond. clg. tr.	18 Willans, 1 Marshall & 2 Cole, Marchent & Morley. Total 21	15 Siemens, 2 E. C. C., 2 Peebles, 2 Westinghouse. Total, 21	6,380	4,977	E. P. S., 400 KW. for 6 hrs ..	Ppr. lead covd., armd., also solid for fdrs.	£429,768
s ..		100	60~, 1-ph.	1 loco., 1 Lanc., cond., econ.	1 Brush, 1 Easton - Anderson, 1 Victor turbine	1 Mordey, 2 International	175	92	.. ..	Ppr, lead covd. conc. B.I.W., direct	£10,000
..		240 & 480	Direct ..	2 B. & W., suphtr., feed htr.	2 Belliss	2 Parker..	132	91.4	D. P., 300 amp.-hrs.	Fdrs. conc., dist. 3-core, Callender..	..
..		110	Direct ..	.. ..	3 Crossley gas	3 Brook	40	..	Chloride, 400 amp.-hrs. ..	Overhead Glover	£2,258
..		115, 230, & 460	Direct ..	6 Lanc., 10 B. & W.	15 Willans	2 Goolden, 2 Siemens, 3 Crompton, 3 Peebles, 8 E. C. C.	6,135	4,584	Tudor, 400 amp.-hrs., lighting. E. P. S., 1,200 amp-hrs., tr.	Triple conc. and single, armd. direct, and solid.. ..	£339,602
		105, 210, 250 & 500	93~, 1-ph. & direct	Temple Back:—12 Lanc., 2 B. & W., stokers, surf. cond.	15 Willans comp., 1 Parsons turbine	13 Siemens, 1 Ferranti, 1 Siemens turbo. dynamo, 1 Dick Kerr	3,216	2,831	E. P. S., 1,500 amp.-hrs. ..	Jute and ppr. Siemens. ppr. B.I.W., conc., lead covd. armd. direct	£458,290
octor				Avonbank:—4 B. & W., stokers, suphtrs., surf. cond.	4 Willans triple	4 Siemens	1,820				
a ..		210	Direct ..	4 Paxman economic, surf. cond.	6 Belliss	6 Parker..	800	380	Pritchetts & Gold, 40 KW. for 10 hrs.	Fdrs. triple conc., dist. 3-core, Callender	£81,725
ddell		230 & 460	Direct ..	2 B. & W., cond.	2 Belliss	2 Parker	100	35	450 amp-hrs.	Callender, single, laid solid..	£13,000
		100	Direct ..	1 Cochrane marine vertical, 1 Marshall loco. ..	1 hor. Brown & May, 1 Marshall semi-portable	1 Greenwood & Batley, 2 Elwell-Parker, 1 Goolden	60	..	E. P. S., 3 sets, 9 KW. for 10 hrs.	Overhead	..
..		110, 220, & 440	Direct ..	5 Lanc., stokers and econ.	3 Burnley Iron Works hor. comp., 2 Belliss vert. comp.	5 E.C.C.	1,030	590	Tudor, ltg. 300 KW. for 1 hr., traction 250 KW. for 1 hr	Armd. and solid Callender, solid, B.I.W...	£74,000
on ..		100 & 200	75~, 1-ph.	6 Lanc., econ., ejector and jet cond.	3 Fowler hor., 1 Alley - Maclellan vertical	3 Fowler, 1 Brown-Boveri	800	318	.. ..	H.p., B I.W.; l.p., Silvertown and B.I.W., part solid, part iron pipes for both	..
..		220 & 440	Direct ..	3 Lanc., econ., cond.	4 Belliss..	4 Siemens	760	320	E. P. S., 46 KW. for 7 hrs. ..	V.r. and v. bit. in c.i. and stoneware pipes and solid ..	£59,223
..		200 & 400	Direct ..	2 Lanc. detart., econ...	2 Belliss..	2 Fowler	132	118	E. P. S., 500 amp.-hrs. ..	Callender	£24,853
ng ..		230	Direct ..	6 Hornsby w.t., jet cond.	6 Belliss	6 M. & P., 2 Sunderland Forge, 1 E. C. C.	538	202.5	Tudor, 250 amp.-hrs.	Conc., jute, lead covd. and armd. laid direct, Callender	£41,550
y ..		240 & 480	.. ..	2 Lanc.	4 Belliss..	5 Parker	425	..	Two 210 amp.-hrs. for ltg., One 300 amp.-hrs., tr.	Callender, laid solid, and armd.	Incomplet
y ..		100 & 200	90~, 1-ph.	4 Lanc. econ.	7 Parsons turbines	7 Parsons	1,500	524	.. ..	H.p. v.r. Silvertown, ppr B.I.W., l.p. v r., B.I.W, Glover & Henley ppr. conc., single and twin	£78,166
heck		220	Direct ..	4 Lanc., stokers, econ., ejector and surf. cond. ..	4 Belliss..	6 Silvertown, 2 Johnson & Phillips	600	293	Chloride, 150 KW. for 5 hrs...	Western Elec. triple conc. armd., also Siemens & Henley	£52,248
..		100, 200 & 400	40~, 1-ph.	5 dryback, 3 B. & W., suphtrs., jet and surf. cond.	2 Paxman triple, 2 Belliss comp., 1 Ferranti vert. comp.	4 Siemens, 1 Ferranti	1,260	1,372	.. ..	V.r. conc., ppr, armd., Siemens	£157,923
..		230 & 460	Direct ..	5 Lanc., stokers, econ., eject cond...	6 Willans	2 Peebles, 6 Siemens	870	488*	Chloride, 27.6 KW. for 5 hrs	Callender, conc. v. bit. lead covd. armd. B.W. single direct and solid	£51,550
		100 & 200	70~, 1-ph., & direct	1 B. & W.	1 Belliss, 2 Waverley, 1 Vortex, turbines (water)	2 E. C. C., A. C.; 3 Laurence Scott, D.C.	115	..	Chloride, 40 KW. for 4 hrs. ..	Ppr. in ducts and covd. overhead, h.p. (5 miles), l.p. covd. overhead	..
rriss		100	93~, 1-ph.	.. ..	Water-wheel	2 Siemens	22	19	.. ..	Ppr., lead covd., B.I.W.	..
y ..		100 & 200	100~, 1-ph.	1 Lanc., 3 B. & W., cond., clg. tr.	3 Marshall, 1 Robey, 1 Parsons ..	2 Mordey, 2 Ferranti, 1 Parsons ..	900	337	.. ..	Brooks semi-solid, Glover & Henley armd. conc ..	..
n ..		100 & 200	100~, 1-ph., & direct	2 Lanc., 2 B. & W., chain grate stokers	6 Willans, 2 Peache	10 Crompton	605	281	Chloride, 36 KW. hrs... ..	H.p. ppr. conc., dist. v.r. and ppr.	£51,353
ur ..		100 & 200	100~, 1-ph., & direct	1 Lanc., 6 B. & W., and econ.	3 Willans, 4 Belliss, 2 Parsons turbines	5 Siemens (2 D.C., 3 A.C.), 2 Parsons A.C., 2 Witting Bros. D.C.	1,700	750	Tudor, 60 KW. for 3 hrs. ..	Bit. fibre, Callender	£133,062
..		210	Direct ..	7 B. & W., stokers	6 Belliss..	6 Parker	1,000	728	E. P. S., 21 KW. for 5 hrs., & Tudor 125 K.W. for 1 hr.	Bit. fibre, lead covd. and armd., Callender	£83,542
l ..		240 & 480	Direct ..	5 B. & W., econ.	4 Belliss..	4 Westinghouse	600	291	Chloride, 600 amp.-hrs ..	Conc. solid throughout, B.I.W.	£35,000
n ..		210	Direct ..	.. ..	.. ..	2 Parker motor transformers ..	80	50	D. P., 20 KW. for 5 hrs. ..	Fdrs. triple conc., dist. 3-core, Callender..	£20,000
y ..		220 & 440	Direct ..	3 Economic, forced draught..	3 Peache, vert. compound	3 Johnson & Phillips	498	300	Tudor, 45 KW. for 3 hrs. ..	Fdrs. drawn in, dist. solid, B I.W., T.C.C.	..
l ..		230 & 460	Direct ..	4 Lanc. (2 fired by Meldrum destructor)	3 Belliss..	3 Johnson Lundell	450	150	50 amps. for 10 hrs.	B.I.W. laid solid in wood troughs..	£21,095
tt ..		240 & 480	Direct ..	3 Lanc., Vicars stokers, surf. cond.	2 Browett-Lindley, 2 Belliss-Morcom	2 Brush, 2 Mavor & Coulson ..	800	150	Tudor, 480 amp.-hrs.	Fdrs. three single, dist., triple conc. Callender	..
..		210	Direct ..	3 Economic, surf. cond.	5 Peache	5 Siemens	575	300	E. P. S. 300 amp.-hrs. ..	Lead covd. and armd.	£31,0

47	CAMBORNE, REDRUTH AND ILLOGAN	Urban Electric Supply Co.	1902	F. S. Hannay ..	240 & 480	.. ..	2 Lanc.	4 Belliss..	6 E. & P., 2 Sund 1 E. C. C.		
48	CAMBRIDGE	Cambridge Elec. Supply Co. ..	1892	H. B. Harvey ..	100 & 200	90~, 1-ph.	4 Lanc. econ.	7 Parsons turbines	7 Parsons		
49	CANTERBURY	Corporation	1899	C. A. Blascheck	220	Direct ..	4 Lanc., stokers, econ., ejector and surf. cond. ..	4 Belliss..	5 Parker	6 Silvertown, 2 Johns	
50	CARDIFF..	Corporation	1894	Arthur Ellis ..	100, 200 &	40~, 1-ph.	5 dryback, 3 B. & W., suphtrs., jet and surf.	2 Paxman triple, 2 Belliss comp.	4 Siemens, 1 Ferranti		

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WORKS OF THE UNITED KINGDOM.

	Total capital expended.	Private supply, eqvt. 8 c.p. lamps.	Lamps added during year.	Public lighting.	No. and H.P. of motors.	Price charged per unit.	System of charging.	Units sold during year.	Pence per Unit Sold. Av. price obtained.	Works cost	Total costs.	Remarks.	
mpton Davies	£167,173	101,473	31,810	235 arc ..	216=838 H.P.	Ltg. 6d. & 2½d., pr. 3d. & 1d.	Max. demand	1,546,569	3.52	1.1	1.51	Ltg. and tra tion, 114 car-motors, 2,850 H.P. 1×420 KW. Willans, Mavor and Coulson, set on order for Dee village stn. All figures are for year ending 31/7/02.	1
.. .. ..	..	9,795	1,371	29 arc, 1 inc.	..	6d.	Flat rate ..	..	..	..	..	Public lighting by contract	2
.. ..	£42,516	16,800	6,350	9 arc, 32 inc.	25=129 H.P.	Ltg. 5d. & 3d., pr. 4d. & 1½d.	Max. demand*	175,890	3.77	1.318	2.042	Destructor, in conj. with electric plant *Change contemplated	3
md. and lead	£22,649	6,396	1.715	..	1=2 H.P. ..	7d. & 4d.	Max. demand	44,562	6	..	..	Lighting only	4
lid	£25,000	8,000	..	16 arc, 25 inc.	7=15 H.P. ..	Ltg. 6d. & 4d., pr. 3d. & 2d.	Max. demand	Contract for	with Messrs. Thos. Parker Ltd. first year's running.			* Including extensions in hand ..	5
, solid ..	£9,500	2,800	..	20 arc ..	3=2 H.P. ..	Ltg. 7d. & 3d., pr. 7d. & 2d.	Max. demand	..	..	..	..	Supply in bulk from British Electric Plant Co.	6
. .. ..	£12,000	..	..	..	..	..	..	..	..	..	..	.. ..	7
.. ..	£59,192	38,676	4,442	..	2=15 H.P...	Ltg. 6d., pr. 3d. ..	Flat rate ..	..	..	..	..	.. ..	8
. .. ..	£50,000	..	..	72 arc, 144 inc.	600 H.P.* ..	Under revision ..	Under revision	..	..	..	..	Ltg. and traction. Pr. for traction 1·5 per unit. * Partly traction	9
d troughs ..	£10,000	2,300	..	..	185	Ltg. 5d., pr. 1½d...	Flat rate ..	..	..	..	..	Supply in bulk from Sth. Lanc. Elec. Tr. & Pr. Co. Ltd.	10
er	£82,000	23,200	1,300	159 arc, 150 inc.	6=24 H.P...	Ltg. 5d., pr. 2d. tr. 1½d. & 1d.*	Flat rate ..	..	..	..	..	Lighting and traction. *First 200,000 units 1½d., above this 1d.	11
e	..	..	..	..	..	Ltg. 7d. & 2½d., pr. 4½d. to 1½d.	Max. demand	..	..	..	..	.. ..	12
.. ..	£22,682	8,265	1,439	..	4=13 H.P. ..	Ltg. 5d., pr. 2½d...	Flat rate ..	97,771	5	2.94	3.98	.. ..	13
d solid* ..	abt. £40,000	14,564	3,443	1594.. ..	30=164 H.P.	Ltg. 4½d., pr. 3½d. & 1½d.	Ltg. flat rate, pr. sldg. sc.	394,624	3.37	1.55	2.0	Ltg. & tr., *Call. & Siemens 3-core ld. cd. arm, ppr. ins. to outer area.	14
d., in Sykes	£35,268	10,262	Private 3,878	725-8cp.) ½amp) Nernst.	1=5 H.P. ..	Ltg. 5d., pr. 3d. ..	Flat rate disc.	123,379	4.30	1.30	2.41	.. ..	15
.. ..	£54,453	31,171	3,000	33 arc, 85 inc.	61=306 H.P.	Ltg. 7d. & 2d., or 4d., pr. 1½d.*	Max. dem. & flat rate	556,923	2.81	.92	1.40	*Trac. 1½d., ld. dis each 75,000 units after first 250,000	16
le Co. ..	..	4,200	..	8 arc, 21 Nernst	3 H.P. ..	Ltg. 6d., pr. 3d. ..	Flat rate ..	..	..	..	..	Started February, 1903	17
.. ..	£67,373	34,825	12,267	48 arc, 57 inc.	56=312 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1½d.	Max. demand	403,393	4.17	1.58	2.09	High and low pressure, generating at 1,100 & 250 v.	18
md. for l.p.;	£103,428	43,604	10,587	182 arc ..	..	Ltg. 5d., 4½d. & 4d. pr. 2½d.	Flat rate & dis.	878,400	3.87	1.67	2.42	Supply by company 1899-7	19
.. ..	..	..	..	24 arc ..	..	6d. & 3d.	Max. demand	..	..	..	..	.. ..	20
.. ..	£67,000	20,447	2,472	17 arc, 32 inc.	5=13 H.P. ..	Ltg. 6d., less 10 % pr. 2d. *	Flat rate ..	261,686	5½ private 3 public	2.25	2.78	*Free wiring 6d.	21
e	£94,204	41,692	4,347	3 arc., 564 inc.	22=92 H.P.	Ltg. 5½d., pr. 2d...	Flat rate ..	756,470	4.19	1.93	2.32	.. ..	22
and e'ware	£221,718	122,000	24,000	60 inc. ..	1,330 H.P. ..	Ltd. 6d. & 2d.. pr. 3d. and 1d.	Max. demand	1,665,560	3.179	0.916	1.237	Station arranged for both lighting and traction	23
d covd., and	£33,000	11,500	9,000	41 arc, 332 inc.	9=26 H.P...	7d. & 3d.	Max. demand	..	..	..	..	Further extension in hand	24
solid, dist.	..	40,100	9,003	54 arc ..	28=615 H.P.	Ltg. 6d., 3d., & 1½d., pr. 2½d. to 1½d.	Max. demand & sldg. scale	547,638	..	..	..	Sep. plant for Corpn. Tramways ..	25
.. ..	£588,323	201,300	28,300	..	402=1,150 H.P.	Ltg. 6d. & 4d., pr. 3d., 2d. & 1½d.	Sliding scale	3,737,419	4.15	1.46	2.36	.. ..	26
armd. in c.i.	£117,000	60,000	10,578	80 arc, 248 inc.	94=280 H.P.	Ltg. 6d. & 3d., pr. 2½d. & 1½d.	Max. demand	..	..	.	..	Lighting and traction	27
B.I.W. and	£178,000	47,472	4,203	263 arc, 290 inc.	28=128 H.P.	Ltg. 7d. & 2d., pr. 2½d., tr. 2d. to 1½d.	Max. demand	2,169,463	4.1	1.52	1.76	Lighting and traction. Installing clg. trs., stokers, cond., &c., ready in Aug. 1903	28
.. ..	£25,000	..	..	..	..	Ltg. 5½d. to 4d., pr. 2½d. to 1½d.	Sliding scale	..	..	..	..	Lighting and traction	29
s or armd.; , 3-core, ld.	£207,482	116,323	23,266	8 arc ..	144=925 H.P.	Ltg. 6d. & 3d. or 5d., pr. 2½d., 1½d. ld., tr. 1·4d.	Max. demand & flat rate	3,802,598	2.02	.662	.813	D.C. & A.C. lighting, D.C. power and traction.	30
nder, solid,	£72,454	30,553	..	166 arc, 1,451 equiv. 8 c.p.	282⅜ H.P. ..	Ltg. 5d. & 3d., pr. 2d. to 1d.	Max. demand	1,619,129	1.92	.7	.88	Lighting and traction	31
d. covd. ..	£231,456	79,309	13,247	..	19=55 H.P.	Ltg. 7d. & 3½d., pr. 3d.	Max. demand	1,260,266	5.07	..	2.46	Lighting and traction, D.C. & A.C. ..	32
.. ..	£429,768	239,509	32,333	51 arc ..	913=4,398 H.P.	Ltg. 4½d., pr. 2d. & 1d., tr. 1d.	Flat rates ..	9,124,228	1.742	.524	.851	Ltg. & trac.; lamps free. Motors & arc lps. on hire. Data to Dec. 31st, 1902	33
.. ..	£10,000	5,621	297	30 arc, 200 inc.	..	6d. & 3½d.	Max. demand & contract	135,057	3½	1.7	2.3	.. ..	34
.. ..	..	6,295	..	101 inc. ..	6=27 H.P...	Ltg. 6d. & 4d. or 5½d., pr. 4d. & 1½d., or 2½d.	Max. demand & flat rate	..	..	..	..	Harold Hale, Engineer-in-chief. 150 KW. B.P. set, & 1 B.&W. boiler on ord.	35
.. ..	£2,258	4,800	400	..	9=24 H.P. ..	Ltg. 6d., pr. 5d. ..	Flat rate ..	..	..	..	..	.. ..	36
olid.. ..	£339,602	193,000	37,000	367 arc, 2,500 inc.	135=600 H.P.	Ltg. 7d. & 1d., tr. 1½d.	Max. demand & flat rate	..	..	..	..	Lighting and traction (725 KW.) ..	37
, lead covd.	£458,290	Ltg. 144,866 pr& ht 32,027	20,481 12,507	310 arc, 10 inc.	262=1,288 H.P.	Ltg. 5d., pr. 1½d...	Flat rate with discount	3,409,758	3.44	1.20	1.71	General supply A.C., special supply D.C. in certain areas	38
.. ..	£81,725	27,414	7,189	..	20=155 H.P.	Ltg. 7d. & 4d., pr. 4d. & 1d.	Max. demand	419,000	4.7	1.45	2.02	Feeds Chislehurst through step-up transformers, at 2,000 volts	39
.. ..	£13,000	5,171	..	12 arc, 36 inc.	5=20 H.P...	Ltg. 6d., pr. 4d. ..	Flat rate ..	39,707	..	..	..	.. ..	40
... ..	..	1,300	..	10 inc ..	..	8d.	Flat rate ..	..	..	..	..	*Messrs. Gillies & Hornidge, engineers and proprietors	41
.. ..	£74,000	28,066	2,500	3 arc, 12 inc.	37=64 H.P.	Ltg. 4d., pr. 3d.-2d.	Flat rate ..	..	..	..	..	Lighting and traction	42
part solid,	..	22,603	3,482	..	12=65 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d., or 2d. to 1½d.	Max. demand & sldg. scale	251,982	4.9	..	..	.. ..	43
nd solid ..	£59,223	35,647	10,979	34 arc, 17 inc.	74=457 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d.	Max. demand	424,993	3.42	1.68	3.41	.. ..	44
.. ..	£24,853	4,827	2,327	14 arc, 400 inc.	13=84·5 H.P.	Ltg. 6d., pr. 3d. to 2½d.	Flat rate ..	170,359*	3.09	1.9	3.6	*Private ltg. 67,538, public ltg. 102,821 units	45
, Callender	£41,550	14,905	2,934	30	16=40 H.P.	6d., 4d. & 3d. or 7d. & 3d.	Sliding sc., or max. dem.	146,480	5.22	2.5	3.6	Max. load at end of summer; load through season heavier than in winter	46
.. ..	Incomplete	4,600	1,000	635 8. c.p. equiv.	6=60 H.P....	Ltg. 7d. & 4d., pr. 4d. & 1½d., tr. 1½d.	Max. demand	112,761*	1.9*	.96*	..	Lighting and traction. * Jan. to April 1903	47
r., B.I.W., in ns & Henley	£78,166	38,556	3,833	1 arc ..	10=32 H.P.	7d.	Flat rate with disc.	431,379	5.90	1.57	2.33	.. ..	48
.. ..	£52,248	17,383	3,859	12 arc, 415 inc.	23=40 H.P.	7d. & 3d. or 6d. ..	Max. demand or flat rate	345,286	4.3	1.55	2.19	.. ..	49
.. ..	£157,283	78,300	32,050	224 arc, 98 inc.	67=458 H.P.	Ltg. 7d. & 2d. or 4½ l., pr. 4d. & 1d.	Max. demand flat rate, & ppt.	1,492,470	3.40	..	..	Centre of town & docks, sup. by d. curnt.	50
.W. single	£51,550	18,717	2,347	45 arc, 20 inc.	..	Ltg. 5d. 4½d. & 4½d. pr. 2d., tr. 2d. 1½d.	Rebate ..	541,430	..	1.65	2.07	Lighting and traction. Pub. off. at 2d. per unit. *Lighting only	51
miles), l.p.	..	..	400	13 arc, 80 inc.	1=67 H.P...	6d. & 3½d.	Discounts ..	..	..	..	..	5 miles overhead to Carlow, driving mo. dynamo. Steam plant at C. as stand by	52
.. ..	..	..	..	16 inc. ..	..	6d.	Flat rate ..	..	..	..	..	.. ..	53
onc ..	..	16,017	3,286	..	2=12 H.P....	Ltg. 7d. & 4d. or 5d., pr. 3d.	Max. demand or flat rate	..	..	..	..	.. ..	54
.. ..	£51,853	16,035	648	21 arc, 272 inc.	28=113 H.P.	Ltg. 6½d., pr. 3d...	Flat rate ..	399,690	3.96	2.05	2.61	Data to Dec. 31st., 1902	55
.. ..	£133,052	34,556	6,879	331 arc, 19 inc.	7=40 H.P....	Ltg. 6d. & 3½d. pr. 3d. tr. 1.9 to 1d.	Max. demand	..	..	..	..	Lighting A.C., Tramway Co. supplied with D.C.	56
.. ..	£83,542	41,264	5,913	173 arc, 891 inc.	175 H.P. ..	Ltg. 4d., pr. 2½d. to 1½d.	Flat rate with discount	914,644	..	..	..	.. ..	57
.. ..	£35,000	16,000	7,000	20 arc, 40 inc.	20=146 H.P.	Ltg. 6d. & 3d., pr. 1½d.	Max. demand	209,000	4.6	.81	1.37	.. ..	58
.. ..	£20,000	6,600	1,700	..	..	8d. & 4d.	Max. demand	..	..	..	..	Fed from Bromley at 2,000 v.	59
.. ..	..	11,155	3,555	..	34=277 H.P.	Ltg. 5d., pr. 2½d. & 2d.	Flat rate ..	299,021	3.5	1.829	2.29	Data to Dec. 31st., 1902	60
.. ..	£21,095	1,316*	..	3 arc ..	3=8 H.P. ..	Ltg. 5d., pr. 2d. ..	Flat rate with disc.	..	4.75	..	..	* Rapidly increasing	61
er	..	10,200	2,740	22 arc, 214 inc.	22½	Ltg. 5d., pr. 2½d.*	Flat rate ..	..	..	..	..	* Large works 1½d. & 1d.	62

6 E. & P., 2 Sunderland Forge, 1 E. C. C.	538	202.5	Tudor, 250 amp.-hrs.	Conc., jute, lead covd. and armd. laid direct, Callender	£41,550	14,905	2,934	30	16=40 H.P.	6d., 4d. & 3d. or 2½d.			
5 Parker	425	..	Two 210 amp.-hrs. for ltg., One 300 amp.-hrs., tr.	Callender, laid solid, and armd.	Incomplete	4,600	1,000	635 8. c.p. equiv.	6=60 H.P....	7d. & 3d. Ltg. 7d. & 4d., pr. 4d. & 1½d., tr. 1½d.			
7 Parsons	1,500	524	.. ..	H.p. v.r. Silvertown, ppr B.I.W., l.p. v r., B.I.W., Glover & Henley ppr. conc., single and twin	£78,166	38,556	3,833	1 arc ..	10=32 H.P.	7d.			
6 Silvertown, 2 Johnson & Phillips	600	293	Chloride, 150 KW. for 5 hrs...	Western Elec. triple conc. armd., also Siemens & Henley	£52,248	17,383	3,859	12 arc, 415 inc.	23=40 H.P.	7d. & 3d. or 6d. ..			
4 Siemens, 1 Ferranti	1,260	1,372	.. ..	V.r. conc., ppr. armd. Siemens									

47	CAMBORNE, REDRUTH AND ILLOGAN	Urban Electric Supply Co.	1902	F. S. Hannay ..	240 & 480	.. ..	2 Lanc.	4 Belliss	1 E. C. C. 5 Parker ..
48	CAMBRIDGE	Cambridge Elec. Supply Co. ..	1892	H. B. Harvey ..	100 & 200	90~, 1-ph.	4 Lanc. econ.	7 Parsons turbines	7 Parsons ..
49	CANTERBURY	Corporation	1899	C. A. Blascheck	220	Direct ..	4 Lanc., stokers, econ., ejector and surf. cond. ..	4 Belliss	6 Silvertown, 2 Johns
50	CARDIFF	Corporation	1894	Arthur Ellis ..	100, 200 & 400	40~, 1-ph.	5 dryback, 3 B. & W., suphtrs., jet and surf. cond.	2 Paxman triple, 2 Belliss comp., 1 Ferranti vert. comp.	4 Siemens, 1 Ferranti
51	CARLISLE	Corporation	1899	C. D. Burnet ..	230 & 460	Direct ..	5 Lanc., stokers, econ., eject cond.	6 Willans	2 Peebles, 6 Siemens
52	CARLOW	J. Alexander	1890	G. Marshall Harriss	100 & 200	70~, 1-ph., & direct	1 B. & W.	1 Belliss, 2 Waverley, 1 Vortex, turbines (water)	2 E. C. C., A. C.; 3 L D.C.
53	CHAGFORD	C. & Devon Electric Light Co. ..	1891	G. H. Reed ..	100	25~, 1-ph.	.. ..	Water-wheel	2 Siemens ..
54	CHATHAM AND ROCHESTER	C., R. & District Elec. Ltg. Co. ..	1888	C. T. Linney ..	100 & 200	100~, 1-ph.	1 Lanc., 3 B. & W., cond., clg. tr.	3 Marshall, 1 Robey, 1 Parsons ..	2 Mordey, 2 Ferranti,
55	CHELMSFORD	C. Electric Lighting Co.	1890	A. H. French ..	100 & 200	100~, 1-ph., & direct	2 Lanc., 2 B. & W., chain grate stokers	6 Willans, 2 Peache	10 Crompton ..
56	CHELTENHAM	Corporation	1895	M. H. Kilgour ..	100 & 200	100~, 1-ph., & direct	1 Lanc., 6 B. & W., and econ.	3 Willans, 4 Belliss, 2 Parsons turbines	5 Siemens (2 D.C., 3 A A.C., 2 Witting Bro
57	CHESTER	Corporation	1893	F. Thursfield ..	210	Direct ..	7 B. & W., stokers	6 Belliss	6 Parker ..
58	CHESTERFIELD	Corporation	1901	R. L. Acland ..	240 & 480	Direct ..	5 B. & W., econ.	4 Belliss	4 Westinghouse
59	CHISLEHURST	Chislehurst Electric Supply Co. ..	1899	R. L. Gamlen ..	210	Direct ..	.. ..	.. ..	2 Parker motor transf
60	CHISWICK	Aberystwith & C. Elec. Supply Corp.	1901	A. W. Money ..	220 & 440	Direct ..	3 Economic, forced draught	3 Peache, vert. compound	3 Johnson & Phillips
61	CLECKHEATON ..	Urban District Council	1902	A. Pickersgill ..	230 & 460	Direct ..	4 Lanc. (2 fired by Meldrum destructor)	3 Belliss	3 Johnson Lundell
62	COATBRIDGE AND AIRDRIE	Scottish H. to H. Electric Co. ..	1894	R. S. Draycott ..	240 & 480	Direct ..	3 Lanc., Vicars stokers, surf. cond.	2 Browett-Lindley, 2 Belliss-Morcom	2 Brush, 2 Mavor & C
63	COLCHESTER	Corporation	1898	A. R. Sillar ..	210	Direct ..	3 Economic, surf. cond.	5 Peache	5 Siemens ..
64	COLNE	Corporation	1901	A. G. Cooper ..	240	Direct ..	1 B. & W., 1 Lanc., stoker, suphtrs., econ., cond.	1 Parsons turbine, 1 Belliss	1 Parsons, 2 Greenwoo
65	COLWYN BAY	Urban District Council	1898	A. R. Tudman ..	220 & 440	Direct ..	2 B & W.	3 Browett-Lindley, 1 Stockport (gas)	4 Bertram Thomas
66	CORK	C. Elec. Tramways & Lighting Co.	1898	H. H. Nalder ..	230 & 460	Direct ..	6 B. & W.	2 Allis, 3 McIntosh & Seymour, 1 Belliss	6 B. T. H. ..
67	COVENTRY	Corporation	1895	J. A. Jeckell ..	200	87~, 1-ph. & 50~, 2-ph.	4 Lanc., stokers, econ., surf cond.	3 Fowler, 1 Belliss, 2 McLaren ..	2 Fowler, 1 Fynn, 1 Schuckert, 2-ph.
68	COWES	I. of W. Electric Light & Power Co...	1903	F. T. Crowe ..	240	Direct ..	.. ..	.. ..	2500/480 volt D. C. tran
69	CREWE	Corporation	1900	H. H. Denton ..	230 & 460	Direct ..	3 Lanc., stokers, econ., ejector cond.	3 Willans	3 Mather & Platt
70	CROMER	Cromer Electricity Supply Co.* ..	1903	Edgar Hesketh ..	240	Direct ..	2 Sugden water tube, suphtrs.	2 Belliss	2 Parker .. ..
71	CROYDON	Corporation	1896	J. Gray Scott ..	200 & 230	60~, 1-ph., & direct	5 Paxman, 4 B. & W., 2 Danks multitub., 3 clg. trs., suphtrs., econ.	10 Belliss, vert., comp. & triple ..	7 B.T.H., A.C.; 3 B.T D.C.
72	DARLINGTON	Corporation	1900	J. R. P. Lunn ..	230 & 460	Direct ..	3 Lanc.	4 Scott & Mountain, 1 Allen ..	4 Scott & Mountain, 1
73	DARTFORD	Urban District Council	1901	A. J. C. Waterland	230 & 460	Direct ..	3 Lanc., stokers, surf. cond.	3 Reavell compound	2 G. E. Co., 1 Lanc. D
74	DARTMOUTH	Urban Electric Supply Co.	1902	G. E. Smith ..	240	.. ..	2 B. & W., suphtrs., Boby heater	2 Belliss	2 Parker ..
75	DARWEN	Corporation	1899	C. Garnett ..	230 & 460	Direct ..	2 Lanc., stokers, ejector cond., 2 Lanc. over destructor	4 Belliss	2 Siemens, 1 Mather &
76	DERBY	Corporation	1898	T. P. Wilmshurst	100 & 200	40~, 1-ph.	6 Lanc., 3 B. & W., econ.	3 Ferranti, 9 Browett-Lindley ..	3 Ferranti, 9 Siemens
77	DEVONPORT	Corporation	1901	J. W. Spark ..	230	Direct ..	5 B. & W., atmo. and surf. cond., feed htrs., econ.	1 Browett-Lindley, 3 Ferranti ..	4 E. C. C. ..
78	DEWSBURY	Corporation	1894	R. H. Campion ..	230 & 440	Direct ..	3 Lanc., econ.	7 Willans	2 Crompton, 2 Peebles 2 Siemens
79	DONCASTER	Corporation	1900	W. Wyld ..	230 & 460	Direct ..	3 Lanc., stokers	6 Willans	5 Mather & Platt, 1 Pe
80	DOVER	D. Electricity Supply Co. (being transferred to Corporation)	1895	L. W. Woodman	100 & 200	100~, 1-ph., & direct	6 B. & W., econ., surf. and ejector cond.	Ltg., 5 Brush, tr. 2 Macintosh & Seymour, 1 Ball & Wood	5 Mordey, A.C., 3 G.E.
81	DUBLIN	Corporation	1892	M. Ruddle ..	200	83~, 1-ph.	4 B. & W., 2 dry-back, feed htrs.	3 Victor Coates, 2 Fowler hor., 1 Willans, 3 Brush vert.	3 E.C.C., 2 Fowler, 1 B arc
82	DUDLEY	Corporation	1899	J. A. T. Marsh ..	230 & 460	Direct ..	6 B. & W., stokers feed htrs. econ. and cond. ..	4 Westinghouse, 1 Ferranti	4 Westinghouse. 1 E.C
83	DUNDEE	Corporation	1893	H. Richardson ..	230	Direct ..	8 Lanc., atmo. and surf. cond., feed htrs., econ..	13 Willans	1 M. & P., 8 Siemens, Int. E. E. Co.
84	DURHAM	County of D. Elec. Pr. Dist. Co. ..	1902	A. S. Esslemont	230 & 460	Direct ..	2 B. & W , suphtr. and jet cond.	3 Brush	3 Brush .. ..
85	EALING	Corporation	1894	J. Douglas Knight	100	40~, 1-ph.	6 Lanc., 4 stokers, cond.	11 Browett-Lindley, 3 Belliss, vert. comp.	Siemens, 9 A.C., 3 arc (
86	EASTBOURNE	Corporation	1882	J. K. Brydges ..	200	50~, 1-ph.	2 Stirling, 2 Hornsby w.t., 1 Economic, 1 B. & W.	2 Ferranti, 2 Willans, 1 Peache ..	2 Ferranti, 3 E.C.C.
87	EAST HAM	Urban District Council	1901	W. C. Ullmann	240 & 480	Direct ..	6 B. & W , cond., clg. tr., 1 Boby heater	5 Musgrave horizontal	5 English Elec Mfg. C
88	ECCLES	Corporation	1898	H. W. Angus ..	200	50~, 1-ph.	2 Lanc.	2 Browett-Lindley, vert., open, 1 ditto, enclosed	2 J. & P., 1 Rosling
89	EDINBURCH	Corporation	1895	F. A. Newington	230	50~, 1-ph., & direct	34 marine, 4 water tube, with stokers	27 Willans, 4 Belliss	17 Siemens, 10 Math 4 Ferranti, 2 E.C.C.
90	EPSOM	Urban District Council	1902	H. F. Foster ..	230 & 460	Direct ..	2 Lanc., econ., 1 dryback, Körting cond. and spray	2 Alley & MacLellan tandem comp. and 1 Belliss comp.	2 Laurence Scott, 1 Dic
91	ERITH	Urban District Council	1903	Geo. E. Heath ..	3,000, 350, & 200	50~, 3-ph.	2 Lanc., cond.	3 Allen	3 International Elec. F
92	EXETER	Corporation	1889	H. D. Munro ..	100	100~, 1-ph.	5 B. & W., 1 suphtr., feed htrs.	3 Fowler, 1 Easton, 1 Brush, 1 Hick Hargreaves, 2 Alley	4 Mordey, 1 Fynn, 1 Thomson-Houston a
93	FALKIRK	Corporation	1903	J. McMillan ..	230	Direct ..	2 Dryback marine, feed heater & econ.	3 Belliss & Morcom	3 Mavor & Coulson ..
94	FAREHAM	Urban District Council	1890	A. Blake ..	100	125~, 1-ph.	2 loco., 1 econ.	1 Ransome hor., 2 Browett-Lindley, 1 Peache, vert., all comp. cond.	2 Thomson-Houston, Phillips, A.C.; 2 T. H
95	FARNWORTH	Urban District Council	1901	J. D. Pember ..	230 & 440	Direct ..	3 Lanc., econ. and cond.	3 Browett-Lindley, 1 Belliss	3 Lanc. Dynamo Co., 1
96	FLEETWOOD	F. & Dist. Elec. Lt. & Pr. Synd. ..	1900	O. Hansom ..	200 & 400	Direct ..	2 B. & W., econ., destructor	2 Willans	2 Johnson-Phillips ..
97	FOLKESTONE	F. Electric Supply Co.	1898	T. Hesketh ..	210 & 420	Direct ..	4 Paxman Economic, surf. cond. (oil burnt in two) 1 B. & W., suphtr.	6 Peache	6 Parker .. ..
98	FORT WILLIAM ..	F. W. Electric Ltg. Co.	1895	I. Reid	150	Direct ..	.. ..	3 Gilkes turbines	2 Laurence Scott, 1 Ge
99	GALWAY	Galway Electric Co.	1889	James Perry ..	110	Direct ..	1 Dowson gas producer plant	2 Hercules water turbines, 1 Crossley gas eng ne	3 Statter, 2 Crompto geared
100	GLASCOW	Corporation	1892	W. A. Chamen ..	250 & 500	Direct ..	20 B. & W., 6 Marine, stokers, suphtrs., cond. ..	22 Willans, 4 Belliss, 1 Marine, 1 Ball & Wood	13 Siemens, 4 Crompto house, 3 Peebles, Schuckert, 2 B. T. H
101	GLOSSOP	Urban Electric Supply Co.	1902	C. E. Knowles ..	240 & 480	Direct ..	2 Economic	3 Belliss	3 Parker .. ..
102	GLOUCESTER	Corporation	1900	W. J. Bache ..	220 & 440	Direct ..	4 Lanc., stokers and econ.	2 Belliss, 1 Willans	4 Silvertown, 2 Mather
103	GODALMING	Urban Electric Supply Co.	1902	R. S. Robertson	240	Direct ..	2 B. & W., chain grates, Boby feed heater ..	2 Belliss	2 Fowler .. ..
104	GORSEINON	G. Electric Light Co.	1894	D. Powell ..	200	Direct ..	1 Cornish	1 Thos. White, 1 Powis	1 Elwell Parker, 1 E. C
105	GOVAN	Corporation	1900	T. C. Parsons ..	250 & 500	Direct ..	4 B. & W.	4 Belliss	2 B. T. H., 1 Silvert Kerr
106	GRANTHAM	Urban Electric Supply Co.	1903	W. E. Milnes ..	240 & 480	Direct ..	2 Hornsby water tube, suphtr., Boby feed heater	2 Belliss, 3rd set about to be added	2 Parker .. ..
107	GRAVESEND	Corporation	1902	C. F. McInnes ..	230	Direct ..	3 B. & W., stokers, econ. and detart.	3 Alley & Macleilan	3 Lancashire Dynamo C
108	GRAYS THURROCK ..	Urban District Council	1901	E. D. Long ..	230 & 460	Direct ..	2 Lanc., destructor and Lanc. blr.	2 Reavell	2 British Schuckert ..
109	GREENOCK	Corporation	1899	W. M. Nelson ..	250 & 500	Direct ..	6 B. & W., stokers, econ., surf. cond.	3 comp., 3 triple, Belliss	7 Silvertown .. ..
110	GRIMSBY	Corporation	1901	W. A. Vignoles ..	230	Direct ..	4 Lanc., 1 Stirling, econ., surf. cond. & clg. tr. ..	8 Belliss	8 Mather & Platt, 2 We
111	GUERNSEY	G. Electricity Supply Co.	1900	A. G. Bird ..	210 & 420	Direct ..	4 B. & W., econ.	4 Belliss	4 Parker .. ..
112	GUILDFORD	G. Electricity Supply Co.	1896	J. M. V. Money-Kent	215	Direct ..	3 B. & W., stokers, surf. cond.	5 Willans	3 Jackson, 2 Rosling ..
113	HALIFAX	Corporation	1892	W. M. Rogerson	100, 230, & 460	25~, 3-ph. & direct	4 Lanc., 6 B. & W., stokers and econ.	3 Belliss vert. triple, 5 Pollit hor. comp., 2 Parsons turbines	8 E. C. C., 2 Parsons ..
114	HANLEY	Corporation	1894	C. A. Cowell ..	100 & 200	100~, 1-ph.	8 Lanc , econ.	6 Brush, 2 Ferranti	4 Mordey, 2 Ferranti arc
115	HARROCATE	Corporation	1897	G. Wilkinson ..	100 & 200	50~, 1-ph.	5 Lanc., stokers, econ., suphtrs.	4 M'Laren (2 comp., 2 triple) vert., 1 Parsons turbine	3 Ferranti, 1 Siemens,
116	HARROW	H. Elec. Light & Power Co.	1896	E. R. Hill ..	220 & 440	Direct ..	4 B. & W., econ.	6 Willans	4 Crompton, 1 Mathe Siemens
117	HASTINGS	Corporation	1888	Russell F. Ferguson	200	100~, 1-ph.	5 B. & W., econ., surf. cond. & clg. tr.	3 Brush, 2 Belliss, 1 Parsons turbine, 1 Peache	5 Brush, 1 Parsons, 1 C
118	HAWICK	Urban Electric Supply Co.	1902	Arthur V. Rye ..	240 & 480	Direct ..	2 B. & W.	2 Belliss	2 Parker .. ..
119	HEBBURN	Northern Counties Elec. Supply Co.	1903	C. S. Vesey Brown C. W. Fairweather	230 & 460	Direct ..	2 B. & W.	2 Allen	2 Crompton .. ..
120	HECKMONDWIKE ..	Urban District Council	1901	G. H. Carter ..	230	Direct ..	2 Stewart, 1 B. & W., 1 Stirling, suphtrs., econ.	3 Reavell, 1 Howden, vert. comp. ..	2 Fowler, 1 Dick Kerr
121	HEREFORD	Corporation	1899	F. G. Poulton ..	220 & 440	Direct ..	2 Lanc., econ., atmo. cond.	3 Belliss (2 comp., 1 triple)	3 Silvertown .. ..
122	HEYWOOD	Corporation	1900	Jas. Stott ..	200 & 400	Direct ..	2 Lanc., econ.	2 Reavell vert. comp.	2 Crompton .. ..
123	HICH WYCOMBE ..	Wycombe (Borough) E. L. & P. Co.	1898	W. E. Brandreth	210 & 420	Direct ..	4 Paxman Economic, 1 Sugden feed htr., 1 B. & W. fired suphtr., cond.	4 Peache, 1 Belliss	5 Parker .. ..
124	HORNSEY	Urban District Council	1902	N. Stainland ..	240 & 480	Direct ..	3 dryback	2 Browett-Lindley	2 Mather & Platt ..
125	HOVE	Hove Electric Lighting Co.	1892	C. B. Smith ..	220	Direct ..	2 Lanc., 5 B. & W., econ.	9 Willans, 1 Belliss	10 Crompton .. ..
126	HOYLAKE & W. KIRBY	Urban District Council	1901	H. G. M'Haffie ..	230	50~, 1-ph.	3 Lanc., econ. and suphtr.	.. ..	.. ..

6 M. & P., 2 Sunderland Forge, 1 E. C. C.	538	202.5	Tudor, 250 amp.-hrs.	Conc., jute, lead covd. and armd . laid direct, Callender	£41,500	14,905	2,984	30	16=40 H.P.	6d., 4d. & 3d. or 7d. & 3d.	Sliding sc., or max. dem.	146,480	5.22
5 Parker	425	..	Two 210 amp.-hrs. for ltg., One 300 amp.-hrs., tr.	Callender, laid solid, and armd.	Incomplete	4,600	1,000	685 8. c.p. equiv.	6=60 H.P...	Ltg. 7d. & 4d., pr. 4d. & 1½d., tr. 1½d.	Max. demand	112,761*	1.9*
7 Parsons	1,500	524	.. ..	H.p. v.r. Silvertown, ppr B.I.W., l.p. v r., B.I.W, Glover & Henley ppr. conc., single and twin	£78,166	38,556	3,833	1 arc ..	10=32 H.P.	7d.	Flat rate with disc.	431,379	5.90
6 Silvertown, 2 Johnson & Phillips	600	298	Chloride, 150 KW. for 5 hrs...	Western Elec. triple conc. armd., also Siemens & Henley	£52,248	17,363	3,859	12 arc, 415 inc.	23=40 H.P.	7d. & 3d. or 6d. ..	Max. demand or flat rate	345,286	4.3
4 Siemens, 1 Ferranti	1,960	1,372	.. . .	V.r. conc., ppr, armd., Siemens	£157,283	78,800	32,050	224 arc, 98 inc.	67=458 H.P.	Ltg. 7d. & 2d. or 4½ l., pr. 4d. & 1d.	Max. demand flat rate, & ppt.	1,492,470	3.40
2 Peebles, 6 Siemens	870	488*	Chloride, 27.6 KW. for 5 hrs	Callender, conc. v. bit. lead covd. armd. B.W. single direct and solid	£51,550	18,717	2,347	45 arc, 20 inc.	..	Ltg. 5d. 4½d. & 4½d. pr. 2d., tr. 2d. 1½d.	Rebate ..	541,430	..
2 E. C. C., A. C.; 3 Laurence Scott, D.C.	115	..	Chloride, 40 KW. for 4 hrs. ..	Ppr. in ducts and covd. overhead, h.p. (5 miles), l.p. covd. overhead	..	..	400	13 arc, 80 inc.	1=67 H.P...	6d. & 3½d.	Discounts ..	..	..
2 Siemens	22	19	.. ..	Ppr., lead covd., B.I.W.	..	..	..	16 inc. ..	..	6d.	Flat rate ..	..	..
2 Mordey, 2 Ferranti, 1 Parsons ..	900	337	.. ..	Brooks semi-solid, Glover & Henley armd. conc ..	..	16,017	3,286	..	2=13 H.P...	Ltg. 7d. & 4d. or 5d., pr. 3d.	Max. demand or flat rate	..	..
10 Crompton	605	281	Chloride, 36 KW. hrs... ..	H.p. ppr. conc., dist. v.r. and ppr.	£51,353	16,035	648	21 arc, 272 inc.	28=113 H.P.	Ltg. 6½d., pr. 3d...	Flat rate ..	399,690	3.96
5 Siemens (2 D.C., 3 A.C.), 2 Parsons A.C., 2 Witting Bros. D.C.	1,700	750	Tudor, 60 KW. for 3 hrs. ..	Bit. fibre, Callender	£133,062	34,556	6,879	331 arc, 19 inc.	7=40 H.P...	Ltg. 6d. & 3½d. pr. 3d. tr. 1.9 to 1d.	Max. demand	..	..
6 Parker	1,000	728	E. P. S., 21 KW. for 5 hrs., & Tudor 125 K.W. for 1 hr.	Bit. fibre, lead covd. and armd., Callender	£83,542	41,264	5,913	173 arc, 891 inc.	175 H.P. ..	Ltg. 4d., pr. 2½d. to 1½d.	Flat rate with discount	914,644	..
4 Westinghouse	600	291	Chloride, 600 amp.-hrs ..	Conc. solid throughout, B.I.W.	£35,000	16,000	7,000	20 arc, 40 inc.	20=146 H.P.	Ltg. 6d. & 3d., pr. 1½d.	Max. demand	209,000	4.6
2 Parker motor transformers ..	80	50	D. P., 20 KW. for 5 hrs. ..	Fdrs. triple conc., dist. 3-core, Callender	£20,000	6,600	1,700	..	..	8d. & 4d.	Max. demand	..	..
3 Johnson & Phillips	498	300	Tudor, 45 KW. for 3 hrs. ..	Fdrs. drawn in, dist. solid, B I.W., T.C.C.	..	11,155	3,555	..	34=277 H.P.	Ltg. 5d., pr. 2½d. & 2d.	Flat rate ..	299,021	3.5
3 Johnson Lundell	450	150	50 amps. for 10 hrs.	B.I.W. laid solid in wood troughs..	£21,095	1,316*	..	3 arc ..	3=8 H.P. ..	Ltg. 5d., pr. 2d. ..	Flat rate with disc.	..	4.75
2 Brush, 2 Mavor & Coulson ..	800	150	Tudor, 480 amp.-hrs.	Fdrs. three single, dist., triple conc. Callender	..	10,200	2,740	23 arc, 214 inc.	22½	Ltg. 5d., pr. 2½d.*	Flat rate ..	..	..
5 Siemens	575	283	E. P. S., 300 KW. hrs. ..	Lead covd. fdrs. in conduits, armd, dist. direct	£41,550	21,965	6,261	7 inc. ..	15=50 H.P.	7d. & 4d., pr. 4d. to 2½d.	Max. demand	215,310	4.92
1 Parsons, 2 Greenwood & Batley ..	260	53.5	P. T. L., 30 KW. for 9 hrs. ..	Fdrs. triple conc., dist. 3-core, ppr., lead covd. B I.W.	£23,000	5,018	2,836	..	11=23 H.P.	Ltg. 6d. & 2½d. or 4½d. pr. 3d. & 1d. or 2½d.	Max. demand & flat rate	51,248	3.95
4 Bertram Thomas	315	180	Tudor, 20 KW. for 4 hrs. ..	Ppr., diatrine, lead covd., armd. direct, Glover	£16,234	10,500	3,000	32 arc ..	1=5 H.P. ..	5d., 4d. & 3d. ..	Flat rates ..	91,076	5.66
6 B. T. H.	1,250	801	Tudor, 1,700 amp.-hrs. ..	Lead covd, ppr., B.I.W., lead covd. and armd, jute Callender.	£315,000	80,652	3,300	85 arc, 51 inc.	114=873 H.P.	Ltg. 5d. to 3d., pr. 1½d. to 1d.	Max. demand & sl. sc.	2,393,078	2.7
2 Fowler, 1 Fynn, 1 ph.; 2 British Schuckert, 2-ph.	1,800	526	.. ..	Ppr., lead covd , conc.; fdrs. solid, dist. armd. direct and in pipes, B.I.W. and Siemens	£102,712	39,605	12,379	40 arc ..	58=340 H.P.	Ltg. 6½., 3d., 1d., pr. 1½d.	Max. demand flat rate	566,731	3.32
2500/480 volt D. C. transformer ..	105	..	800 amp.-hrs.	Fdrs. triple conc., dist. 3-core, jute, lead covd. armd. direct Callender*	Incomplete	..	..	..	..	Ltg. 7d. & 4d. or 6d., pr. 4d. & 1½d. or 2½d.	Max. demand & flat rate	..	..
3 Mather & Platt	550	255	Hart, 400 amp.-hrs.	Ppr. & v. r. in wood troughs, Henley	£43,587	14,093	..	7 arc, 702 inc.	15=50 H.P.	6d. & 3d. or 4½d., pr. 3d. to 2d.	Max. demand & flat rate	353,228	3.90
2 Parker..	190	..	40 amps. for 10 hrs.	3 single, laid solid in wood troughs, Callender	..	..	..	..	..	Ltg. 7d. & 4d. or 6d., pr. 4d. & 1½d. or 2½d.	Max. demand & flat rate	..	..
7 B.T.H., A.C.; 3 B.T.H., 1 E.C.C., D.C.	3,280	2,027	Tudor, 1,200 amp.-hrs. ..	Jute l.ad covd. & armd. conc. & triple v.b., solid, Callender	£228,713	89,145	20,145	392 arc, 26 inc.	15=50 H.P.	Ltg. 7d. & 2d. or 5d., pr. 2½d.	Max. demand & flat rate	3,130,117	3.03
4 Scott & Mountain, 1 Parker ..	470	241	D. P., 50 amp. for 5 hrs. ..	Ppr. & fibre triple conc., armd., direct	£39,921	16,530	6,336	40 arc ..	19=45 H.P...	Ltg. 5d. to 4d., pr. 2d. to 1½d.	Sliding scale	215,343	4.37
2 G. E. Co., 1 Lanc. Dynamo Co. ..	500	..	Ashmore, Benson, Pease, & Co., 50 KW. for 3 hrs.	Fdrs. triple conc., dist. 3-core, all ppr. lead covd. solid	£34,000	6,000	..	6 arc, 340 inc.	..	Ltg. 7d. & 2d. or 5d., pr. 2½d.	Max. demand & flat rate	..	..
2 Parker	180	31.3	D. P., 260 cells, 160 KW. hrs.	Fdrs. armd. also laid solid, dist, solid, st. ltg. 3 & 4 core armd.	.	2,611	741	10 arc, 140 inc.	..	Ltg. 7d. & 4d. or 6d., pr. 4d. & 1½d. or 2½d.	Max. demand & flat rate	8,084 (3 mo.)	4½
2 Siemens, 1 Mather & Platt, 1 Peebles	950	540	Tudor, 500 amp.-hrs.	Armd fdrs. and dist , also Doulton conduit, Callender and B I.W.	£48,060	15,363	3,312	18 arc, 150 inc.	30=50 H.P.	Ltg. 4½d., pr. 3d., tr. 1½d.	Flat rates ..	610,612	2.34
3 Ferranti, 9 Siemens	2,300	1,100	.. ..	Paper and rubber	£157,150	66,030	11,000	80 arc, 328 inc.	169=720 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d.	Max. demand & sl. scale	..	..
4 E. C. C.	1,360	500	A. B. P., 75 KW. for 5 hrs. ..	V. b. lead covd. and armd. Callender, and solid ..	£90,000	6,146	..	20 arc, 40 inc.	2=3 H.P. ..	5d. & M. Dd., 7d. & 3d.	Flat rate & Max. demand	1,102,784	..
2 Crompton, 2 Peebles, 1 Dick Kerr, 2 Siemens	700	563	Tudor, and Chloride, 98 amp. for 4 hrs.	Fdrs., 3 and 2 conc., dist. single, all lead covd., armd. direct. Siemens, Callender, B.I.W. & Waring	£42,995	21,207	2,822	32 arc, 32 inc.	38=142 H.P.	Ltg. 6d. & 3½d., pr. 4d. & 1d.	Max. demand	315,132	3.94
5 Mather & Platt, 1 Peebles	688	154	400 amp.-hrs.	Callender fibre	£46,727	11,792	3,244	1 arc ..	14=67 H.P.	5d. 4½d. & 3d. ..	Max. demand	..	..
5 Mordey, A.C., 3 G.E.C., D.C. ..	900	635	Tudor, 30 KW. for 10 hrs. ..	Fdrs., v.r. conc., Silvertown; dist. ppr. conc. B.I.W. and Glover in pipes	£95,536	22,314	2,946	40 arc, 134 inc.	25=669 H.P.	Ltg. 7d. & 3d., or 6d. w. rebate, pr. 2½d.	Max. demand & flat rate	885,774 Tr. 296,908	3.396
3 E.C.C., 2 Fowler, 1 B.T.H., 3 Brush arc	900	720	.. ..	V.B. conc., solid	£94,000	33,000	2,900	81 arc ..	8=30 H.P...	6d. to 5d.	Flat rate ..	625.580 (Dec. 1901)	..
4 Westinghouse. 1 E.C.C.	1,200	Ltg. 353, tr. 550.	.. ..	Triple conc., lead covd., and v. bit. Callender	£45,000	19,260	15,115	56 arc, 96 inc	10=93 H.P.	6d. & 1½d. or 5d. ..	Time switch & flat rate	..	1,338,320 gentd.
1 M. & P., 8 Siemens, 3 Parker, 1 Int. E. E. Co.	2,299	1,559	E. P. S. 248 KW. hrs. ..	Bare cpr., v. r., and Callender lead covd. in ducts. ..	£73,829	58,558	13,411	67 arc ..	79	L'g. 4d. to 3d., pr. 2d., tr. 1½d.	Flat rate with disc.	..	..
3 Brush	400	151	Hart, 240 amp.-hrs.	Callender, solid	..	6,700	..	..	..	7d. & 2½d.	Max. demand	..	..
Siemens, 9 A.C., 3 arc (1,800 v.) ..	1,162	696	Tudor, 4,300 amp.-hrs. for exciting	Jute (h.p.) and v. bit. (l.p.) Callender; some Siemens..	£137,548	58,273	11,609	72 arc, 1,216 inc.	16=45 H.P.	Ltg. 6d. to 4d.; 8d. & 3d.m.d., pr. 3d. & 2½d.	Sliding scale & dis. & mx.d.	865,430	5.6
2 Ferranti, 3 E.C.C.	1,200	629	.. ..	Fdrs., ppr., lead covd., solid; dist. ditto and v. r. ..	£148,883	45,887	8,460	99 arc ..	..	Ltg. 6½d., pr. 4d. .	Flat rate	669,132	6.4
5 English Elec Mfg. Co.	1,275	690	.. ..	Fdrs., lead covd. in conduits, dist. Callender, solid ..	..	20,103	11,580	168 arc, 134 inc.	8=40 H.P...	Ltg. 7d. & 2d. or 5½d., pr. 2½d., tr. 2½d.	Max. demand & flat rate	1,254,266	..
2 J. & P., 1 Rosling	280	135	Pritchetts, 16 KW. for 9 hrs.	H.p. conc., Glover diatrine, and B.I W., l.p. twin, Callender, solid	£19,302	10,374	1,662	2 arc, 426 inc.	2=6 H.P. ..	7d. & 2d., or 6d. to 4d.	Max. demand & flat rates	..	..
17 Siemens, 10 Mather & Platt, 4 Ferranti, 2 E.C.C.	10,477	7,174	3,600 amp.-hrs.	.. ..	£765,612	419,806, ltg. only	71,589	880 arc ..	957=4,078 H.P	Ltg. 3¾d., pr. 1½d.	Discount ..	9,039,112	Prv. 3.34; pr. 1.19; pb. 2.05
2 Laurence Scott, 1 Dick Kerr ..	150	..	Pritchetts & Gold	Callender, solid	£30,000	1,450	..	12 arc, 250 inc.	5=19 H.P...	Ltg. 6½d., pr. 3d...	Flat rate ..	84,030*	..
3 International Elec. Eng.	350	85	.. ..	Lead covd., ppr., laid solid, h.p. armd., Callender ..	£43,000	3,500	3,500	18 arc, 644 Nernst.	2=12½ H.P...	Ltg. 7d. & 3d. or 5d., pr. 3d. & 1½d.	Max. demand & flat rate	..	..
4 Mordey, 1 Fynn, 1 Ferranti, 2 Thomson-Houston arc.	670	412	.. ..	Concentric	£32,000	26,000	4,000	33 arc ..	12=40 H.P. .	Ltg. 6d. to 4d., pr. 3d.	Sliding scale	..	..
3 Mavor & Coulson	300	..	256 cells, 100 amp.-hrs. ..	Triple conc., vulc. bit. lead covd. in e'ware conduits ..	..	3,172	3,172	35 arc, 70 inc.	7=15 H.P. ..	Ltg. 6d., pr. 2d. ..	Flat rate with discount	..	..
2 Thomson-Houston, 1 Johnson-Phillips, A.C.; 2 T. H. arc.	140	63	.. ..	B I.W. twin and conc., and Okonite	£11,490	3,050	250	27 arc, 109 inc.	..	7d.	Flat rate ..	..	..
3 Lanc. Dynamo Co., 1 Westinghouse	610	350	Tudor, 400 amp.-hrs.	B I.W. 5-core fdrs., 3-core dist., and Glover 3 single lead covd , solid in Howard conduit	£33,115	11,185	7,117	45 arc, 63 inc.	50=255½ H.P.	Ltg. 7d. & 3d. or 5½d., pr. 2½d. to 1½d., tr. 1d	Max. demand & flat rate	445,912	1.74
2 Johnson-Phillips	120	96	Chloride, 600 amp.-hrs. ..	Triple core and 3-core ppr. lead covd. and armd. ..	£30,000	8,000	2,000	12 arc, 600 inc.	63 H.P. ..	Ltg. 6d., pr. 3d.	Flat rate ..	..	..
6 Parker	1,180	650	Tudor, 170 KW. for 3 hrs. ..	Vulc bit. solid. triple conc. and 3-core armd. direct, Callender; dble. conc. solid for Hythe (4½ miles).	£106,600	40,699	8,167	66 arc, 132 inc.	19=73 H.P...	Ltg. 7d., 4½., & 2d., or 6d., pr. 7d. & 1d.	Max. demand & flat rate	540,320	5.25
2 Laurence Scott, 1 General Electric	118	120	E. P. S., 70 amp. for 9 hrs. ..	Overhead and underground, Glover dia. armd.	£11,091	5,000	200	6 arc, 60 inc.	2=4 H.P. ..	Ltg. 6½d., pr. 4½d.	Flat rate ..	..	..
3 Statter, 2 Crompton, 1 Holmes, geared	153	84	Tudor, 24 KW. for 3 hrs. ..	Bare copper and diatrine single in bitumen	£10,000	3,654	90	8 arc, 4 inc...	8=8.5 H.P. ..	Ltg. 5d., pr. 3d. ..	Flat rate ..	68,641	4½
13 Siemens, 4 Crompton, 2 Westinghouse, 3 Peebles, 2 Walker, 2 Schuckert, 2 B. T. H.	19,200	7,550	Tudor, (1) 250 a. for 5 hrs., (2) 1,000 a. for 2 hrs.	Paper and bit. yarn conc. feeders: network, lead covd. and vulc bit. solid	£836,000	338,342	126,000	348 arc ..	427=1894 H.P.	Ltg. 6d. & 1d. or 2½d., pr. 1½d.	Max. demand & flat rate	..	..
3 Parker	..	..	D. P., 400 amp.-hrs. 200 cells	Callender single, laid solid	..	..	..	..	..	Ltg. 7d. & 4d., pr. 4d. & 1½d.	Max. demand	..	..
4 Silvertown, 2 Mather & Platt ..	750	304	E. P. S., 1,000 amp.-hrs. ..	Triple conc., Callender, solid	£59,047	20,400	3,900	54 arc, 4 Nernst	13=32 H.P...	Ltg. 6d. & 2d., pr. 3d. & 1½d.	Max. demand	..	..
2 Fowler..	200	85	D. P. Co., 350 amp. hrs. ..	Solid, in wood trough, for public lamps, 3-core lead covd. and armd., Callender.	..	6,058	1,330	943	4=6½ H.P. ..	7d. & 4d., or 6d. ..	Max. demand & flat rate	68,800	3.49
1 Elwell Parker, 1 E. C. C.	60	20	.. ..	Overhead 2-wire, Henley	£1,000	1,160	200	27 inc. ..	..	6d. & 1s. 3d. per c.p.p.a.	Flat rate & contract	..	..
2 B. T. H., 1 Silvertown, 1 Dick Kerr	610	462	Tudor, 160 amp. hrs.* ..	Single lead covd. and armd. direct	£50,000	30,000	10,000	100 arc (extending)	42=286 H.P.	Ltg. 6d. & 1d. or 3½d., pr. 2d. to 1½d.	Max. demand & flat rate	409,397	3.16
2 Parker	180	..	D. P., 260 cells, 600 amp.-hrs.	3 way solid and 3-core armd., Callender	..	8,000	..	..	4=20 H.P. ..	Ltg. 7d. & 3d. or 6d., pr. 4d. & 1d. or 2½d.	Max. demand & flat rate	..	..
3 Lancashire Dynamo Co.	600	..	Verity, 500 amp.-hrs... ..	Western Electric lead covd., ppr. solid	£35,000	..	..	27 arc ..	..	Ltg. 7d. & 3d., pr. 3d.	Max. demand	..	..
2 British Schuckert	200	90	D.P., 17 KW. for 10 hrs ..	Triple conc. bit. armd., Callender	£15,000	5,500	215	215	4=15 H.P. ..	3 2-5d., 7d. & 4d., pr. 2½d.	Max. demand	100,000	Pr. 5½d. Pb. 3 2-5d.
7 Silvertown	1,100	600	Tudor, 100 KW. for 4 hrs. ..	Vulc. bit., solid and in C.W. casing, Callender	£40,424	28,136	15,656	50 arc ..	49=500 H.P.	Ltg. 7d. & 1½d. or 5½d., pr. 2d., tr. 1½d.	Max. demand & flat rate	..	..
8 Mather & Platt, 2 Westinghouse..	900	..	Tudor, 600 amp.-hrs.	Fdrs. conc., dist. triple conc., B.I.W. solid	£72,000	21,334	8,273	80 arc ..	16=45 H.P...	Ltg. 4½d., pr. 2½d. to 1½d.	Flat rate ..	653,438	2.51
4 Parker	510	230	D. P., 35 KW. for 5 hrs.; Tudor, 100 KW. for 5 hrs.	Fdrs. triple conc., armd., and 2-core solid; dist. 3-core armd. and solid, Callender	£90,696	30,047	19,198	12 inc. ..	552 H.P. ..	Ltg. 7d. & 3d., pr. 4d. & 1½d. or 2½d.	Max. demand & flat rate	182,223	4.06
3 Jackson, 2 Rosling	200	..	Chloride, 300 amp.-hrs. ..	Callender, v. bit. and fibre, iron armd.	£26,855	8,000	2,000	..	..	Ltg. 6d., pr. 3d.	Flat rate ..	..	..
8 E. C. C., 2 Parsons	3,200	2,143	Chloride, 150 KW. for 6 hrs.	V. r. Siemens, v. bit. and lead covd. ppr., Callender ..	£212,579	80,172	10,272	69 arc, 100 inc	77=294 H.P.	Ltg. 4d., pr. 2d. ..	Flat rate ..	3,187,369	2.19
4 Mordey, 2 Ferranti A.C., 2 Brush arc	1,214	677	.. ..	H. p. v. r. and ppr., l.p. Callender single, and B.I.W...	£73,330	44,973	4,549	68 arc, 191 inc.	36=30 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d.	Max. demand	..	..
3 Ferranti, 1 Siemens, 1 Parsons ..	1,150	660	.. ..	Conc , ppr., lead covd., B.I.W. and Siemens	£92,200	45,190	7,995	60 arc, 170 inc.	36=130 H.P.	Ltg. 6d., 4d., 3d. or 6d. & 2d., pr. 2d.	Max. demand	761,136	4.75
4 Crompton, 1 Mather & Platt, 1 Siemens	535	250	E. P. S.	Bare cpr., and Callender in ducts and solid	£56,892	18,000	..	..	14=55 H.P.	Ltg. 8d. & 4d., pr. 4d.	Max. demand & flat rate	..	..
5 Brush, 1 Parsons, 1 Crompton ..	1,235	602	Tudor, 65 KW. hrs.	Paper, diatrine, Glover	£128,944	33,443	4,015	104 arc ..	7=8 H.P....	6d., or 10s. per an. per lp. & 1½d. per u.	Flat rate & Hopkinson	803,761	Priv. 5 Pub. 3.55
2 Parker	180	88	D. P., 400 amp.-hrs.	Vulc. bit., laid solid in wood trough, Callender.. ..	..	7,319	..	10 arc, 105 inc.	10=37 H.P.	Ltg. 7d. & 3d., pr. 4d. & 1½d.	Max. demand	38,695	4.1
2 Crompton	400	..	232 Chloride, 500 amp.-hrs...	Callender, single, laid solid	..	..	..	10 arc, 150 inc	..	Ltg. 4½d., pr. 2d. to 1½d.	Flat rate & sliding scale	..	..
2 Fowler, 1 Dick Kerr	380	115	Tudor, 350 amp.-hrs.; Chloride, 350 amp. hrs.	Ppr., solid, Henley	£20,000	7,285	1,932	10 arc, 224 inc.	10=36 H.P...	Ltg. 6d. & 3d. or 5d., pr. 2d. or 1d.	Max. demand & flat rate	73,631	Pri. 4.39 Pub 2.
3 Silvertown	450	147	Chloride, 660 amp.-hrs. ..	V. r. in bit., Silvertown	£25,230	9,572	1,115	..	13=42 H.P...	Ltg. 6d. & 4d., pr. 3d. & 2d.	Max. demand	108,815	4.85
2 Crompton	120	41	Marquand, 300 amp.-hrs. ..	V. bit. and ppr., lead covd., solid	£15,000	3,330	..	4 arc.. ..	13=64 H.P. .	Ltg. 6d. & 3d., pr. 2½d. & 1½d.	Accdg. to lps. installed ..	39,679	4.23
5 Parker	820	380	Tudor, 120 KW. for 3 hrs. ..	Fdrs. conc., dist. 3-core, all armd. direct, Callender ..	£60,000	28,037	6,020	10 arc, 238 inc.	..	Ltg. 5d. & 2d., pr. 4d. & 1d.	Max. demand	406,750	3.47
2 Mather & Platt	600	250	292 E. P. S., 1,200 amp.-hrs.	Siemens, triple conc., ppr., lead covd. armd. & laid solid	£73,885	12,000	..	50 arc. ..	2=3 H.P. ..	Ltg. 7d. & 2d., pr. 2½d.	Max. demand & flat rate	..	..
10 Crompton	1,206	751	Tudor, 127 KW.	Bare cpr. in ducts, insd. cable in iron pipes	£127,103	..	..	..	..	..	..	..	..

p. v.r., B.I.W ,	£78,166	38,556	3,833	equiv. 1 arc ..	10=32 H.P.	4d. & 1½d., tr. 1½d. 7d.	Flat rate with disc.	431,379	5.90	1.57	2.33	.. ..	48
										1.55	2.19	.. ..	49

125 HOVE	Hove Electric Lighting Co.	1892	C. B. Smith ..	220	Direct ..	3 dryback	2 Browett-Lindley	2 Mather & Platt ..
126 HOYLAKE & W. KIRBY	Urban District Council	1901	H. G. M'Haffie..	230	50~, 1-ph.	3 Lanc., econ. and suphtr.	9 Willans, 1 Belliss	10 Crompton ..

nay ..	240 & 480	.. ..	2 Lanc.	4 Belliss	5 Parker	225	..	2 to 3 10 amp.-hrs. for lgt., One 800 amp.-hrs., tr.	Callender, laid solid, and armd.	
rvey ..	100 & 200	90~, 1-ph.	4 Lanc. econ.	7 Parsons turbines	7 Parsons	1,500	524	.. ..	H.p. v.r. Silvertown, ppr. B.I.W., l.p. v r., B.I.W., Glover & Henley ppr. conc., single and twin	
ascheck	220	Direct ..	4 Lanc., stokers, econ., ejector and surf. cond. ..	4 Belliss	6 Silvertown, 2 Johnson & Phillips	600	293	Chloride, 150 KW. for 5 hrs...	Western Elec. triple conc. armd., also Siemens & Henley	
illis ..	100, 200 & 400	40~, 1-ph.	5 dryback, 3 B. & W., suphtrs., jet and surf. cond.	2 Paxman tripie, 2 Belliss comp., 1 Ferranti vert. comp.	4 Siemens, 1 Ferranti	1,260	1,372	.. . .	V.r. conc., ppr, armd., Siemens	£
rnet ..	220 & 460	Direct ..	5 Lanc., stokers, econ., eject cond...	6 Willans	2 Poebles, 6 Siemens	870	488*	Chloride, 27.6 KW. for 5 hrs	Callender, conc. v. bit. lead covd. armd. B.W. single direct and solid	
hall Harris	100 & 200	70~, 1-ph., & direct	1 B. & W.	1 Belliss, 2 Waverley, 1 Vortex, turbines (water)	2 E. C. C., A. C.; 3 Laurence Scott, D.C.	115	..	Chloride, 40 KW. for 4 hrs. ..	Ppr. in ducts and covd. overhead, h.p. (5 miles), l.p. covd. overhead	
ged ..	100	90~, 1-ph.	.. ..	Water-wheel	2 Siemens	22	19	.. ..	Ppr., lead covd., B.I.W.	
aney ..	100 & 200	100~, 1-ph.	1 Lanc., 3 B. & W., cond., clg. tr.	3 Marshall, 1 Robey, 1 Parsons ..	2 Mordey, 2 Ferranti, 1 Parsons ..	900	337	.. ..	Brooks semi-solid, Glover & Henley armd. conc ..	
anch ..	100 & 200	100~, 1-ph., & direct	2 Lanc., 2 B. & W., chain grate stokers	6 Willans, 2 Peache	10 Crompton	605	281	Chloride, 86 KW. hrs... ..	H.p. ppr. conc., dist. v.r. and ppr.	
lligour ..	100 & 200	100~, 1-ph., & direct	1 Lanc., 6 B. & W., and econ.	3 Willans, 4 Belliss, 2 Parsons turbines	5 Siemens (2 D.C., 3 A.C.), 2 Parsons A.C., 2 Witting Bros. D.C.	1,700	750	Tudor, 60 KW. for 3 hrs. ..	Bit. fibre, Callender	£
sfield ..	210	Direct ..	7 B. & W., stokers	6 Belliss	6 Parker	1,000	728	E. P. S., 21 KW. for 5 hrs., & Tudor 125 K.W. for 1 hr.	Bit. fibre, lead covd. and armd., Callender	
bland ..	240 & 480	Direct ..	5 B. & W., econ.	4 Belliss	4 Westinghouse	600	291	Chloride, 600 amp.-hrs ..	Conc. solid throughout, B.I.W.	
amlen ..	210	Direct ..	.. ..	.. ..	2 Parker motor transformers ..	80	50	D. P., 20 KW. for 5 hrs. ..	Fdrs. triple conc., dist. 3-core, Callender	
Toney ..	220 & 440	Direct ..	3 Economic, forced draught..	3 Peache, vert. compound	3 Johnson & Phillips	498	300	Tudor, 45 KW. for 3 hrs. ..	Fdrs. drawn in, dist. solid, B I.W., T.C.C.	
rsagill ..	230 & 460	Direct ..	4 Lanc. (2 fired by Meldrum destructor)	3 Belliss	3 Johnson Lundell	450	150	50 amps. for 10 hrs.	B.I.W. laid solid in wood troughs..	
raycott ..	240 & 480	Direct ..	3 Lanc., Vicars stokers, surf. cond.	2 Browett-Lindley, 2 Belliss-Morcom	2 Brush, 2 Mavor & Coulson ..	800	150	Tudor, 480 amp.-hrs.	Fdrs. three single, dist., triple conc. Callender	
llar ..	210	Direct ..	3 Economic, surf. cond.	5 Peache	5 Siemens	575	288	E. P. S., 300 KW. hrs. ..	Lead covd. fdrs. in conduits, armd, dist. direct	
ooper ..	240	Direct ..	1 B. & W., 1 Lanc., stoker, suphtrs., econ., cond.	1 Parsons turbine, 1 Belliss	1 Parsons, 2 Greenwood & Batley ..	260	53.5	P. T. L., 30 KW. for 9 hrs. ..	Fdrs. triple conc., dist. 3-core, ppr., lead covd. B I.W.	
ndman ..	220 & 440	Direct ..	2 B & W.	3 Browett-Lindley, 1 Stockport (gas)	4 Bertram Thomas	315	180	Tudor, 20 KW. for 4 hrs. ..	Ppr., diatrine, lead covd., armd. direct, Glover	
Talder ..	230 & 460	Direct ..	6 B. & W.	2 Allis, 3 McIntosh & Seymour, 1 Belliss	6 B. T. H.	1,250	801	Tudor, 1,700 amp.-hrs. ..	Lead covd, ppr., B.I.W., lead covd. and armd, jute Callender.	£
ckell ..	200	87~, 1-ph. & 50~, 2-ph.	4 Lanc., stokers, econ., surf cond.	3 Fowler, 1 Belliss, 2 McLaren ..	2 Fowler, 1 Fynn, 1 ph.; 2 British Schuckert, 2-ph.	1,800	526	.. ..	Ppr., lead covd., conc.; fdrs. solid, dist. armd. direct and in pipes, B.I.W. and Siemens	£
rowe ..	240	Direct ..	.. ..	.. ..	2500/480 volt D. C. transformer ..	105	..	800 amp.-hrs.	Fdrs. triple conc., dist. 3-core, jute, lead covd. armd. direct Callender*	Inc
Denton ..	230 & 460	Direct ..	3 Lanc., stokers, econ., ejector cond.	3 Willans	3 Mather & Platt	550	255	Hart, 400 amp.-hrs.	Ppr. & v. r. in wood troughs, Henley	
Hesketh ..	240	Direct ..	2 Sugden water tube, suphtrs.	2 Belliss	2 Parker..	190	..	40 amps. for 10 hrs.	3 single, laid solid in wood troughs, Callender	
Scott ..	200 & 230	60~, 1-ph., & direct	5 Paxman, 4 B. & W., 2 Danks multitub., 3 clg. trs., suphtrs., econ.	10 Belliss, vert., comp. & triple ..	7 B.T.H., A.C.; 3 B.T.H., 1 E.C.C., D.C.	3,280	2,027	Tudor, 1,200 amp.-hrs. ..	Jute lead covd. & armd. conc. & triple v.b., solid, Callender	£
Lunn ..	230 & 460	Direct ..	3 Lanc.	4 Scott & Mountain, 1 Allen ..	4 Scott & Mountain, 1 Parker ..	470	241	D. P., 50 amp. for 5 hrs. ..	Ppr. & fibre triple conc., armd., direct	
C. Water-	230 & 460	Direct ..	3 Lanc., stokers, surf. cond...	3 Reavell compound	2 G. E. Co., 1 Lanc. Dynamo Co. ..	500	..	Ashmore, Benson, Pease, & Co., 50 KW. for 3 hrs.	Fdrs. triple conc., dist. 3-core, all ppr. lead covd. solid	
Smith ..	240	.. ..	2 B. & W., suphtrs., Boby heater	2 Belliss..	2 Parker	180	31.3	D. P., 260 cells, 160 KW. hrs.	Fdrs. armd. also laid solid, dist, solid, st. ltg. 3 & 4 core armd.	
ett ..	230 & 460	Direct ..	2 Lanc., stokers, ejector cond., 2 Lanc. over destructor	4 Belliss..	2 Siemens, 1 Mather & Platt, 1 Peebles	950	540	Tudor, 500 amp.-hrs.	Armd fdrs. and dist, also Doulton conduit, Callender and B I.W.	
Tilmshurst	100 & 200	40~, 1-ph.	6 Lanc., 3 B. & W., econ.	3 Ferranti, 9 Browett-Lindley ..	3 Ferranti, 9 Siemens	2,300	1,100	.. ..	Paper and rubber	£
Spark ..	230	Direct ..	5 B. & W., atmo. and surf. cond., feed htrs., econ.	1 Browett-Lindley, 3 Ferranti ..	4 E. C. C.	1,360	500	A. B. P., 75 KW. for 5 hrs. ..	V. b. lead covd. and armd. Callender, and solid ..	
Campion..	220 & 440	Direct ..	3 Lanc., econ.	7 Willans	2 Crompton, 2 Peebles, 1 Dick Kerr, 2 Siemens	700	563	Tudor, and Chloride, 98 amp. for 4 hrs.	Fdrs., 3 and 2 conc., dist. single, all lead covd., armd. direct. Siemens, Callender, B.I.W. & Waring	
ld ..	230 & 460	Direct ..	3 Lanc., stokers	6 Willans	5 Mather & Platt, 1 Peebles	688	154	400 amp.-hrs.	Callender fibre	
Woodman	100 & 200	100~, 1-ph., & direct	6 B. & W., econ., surf. and ejector cond.	Ltg., 5 Brush, tr. 2 Macintosh & Seymour, 1 Ball & Wood	5 Mordey, A.C., 3 G.E.C., D.C. ..	900	635	Tudor, 30 KW. for 10 hrs. ..	Fdrs., v.r. conc., Silvertown; dist. ppr. conc. B.I.W. and Glover in pipes	
iddle ..	200	88~, 1-ph.	4 B. & W., 2 dry-back, feed htrs.	3 Victor Coates, 2 Fowler hor., 1 Willans, 3 Brush vert.	3 E.C.C., 2 Fowler, 1 B.T.H., 3 Brush arc	900	720	.. ..	V.B. conc., solid	
. Marsh ..	230 & 460	Direct ..	6 B. & W., stokers feed htrs. econ. and cond. ..	4 Westinghouse, 1 Ferranti	4 Westinghouse. 1 E.C.C.	1,200	Ltg. 353, tr. 550.	.. ..	Triple conc., lead covd., and v. bit. Callender	
hardson..	230	Direct ..	8 Lanc., atmo. and surf. cond., feed htrs., econ..	13 Willans	1 M. & P., 8 Siemens, 3 Parker, 1 Int. E. E. Co.	2,299	1,559	E. P. S. 248 KW. hrs. ..	Bare cpr., v. r., and Callender lead covd. in ducts. ..	
Esslemont	230 & 460	Direct ..	2 B. & W, suphtr. and jet cond.	3 Brush	3 Brush	400	151	Hart, 240 amp.-hrs.	Callender, solid	
glas Knight	100	40~, 1-ph.	6 Lanc., 4 stokers, cond.	11 Browett-Lindley, 3 Belliss, vert. comp.	Siemens, 9 A.C., 3 arc (1,800 v.) ..	1,162	696	Tudor, 4,300 amp.-hrs. for exciting	Jute (h.p.) and v. bit. (l.p.) Callender; some Siemens..	£
Drydges ..	200	50~, 1-ph.	2 Stirling, 2 Hornsby w.t., 1 Economic, 1 B. & W.	2 Ferranti, 2 Willans, 1 Peache ..	2 Ferranti, 3 E.C.C.	1,200	629	.. ..	Fdrs., ppr., lead covd., solid; dist. ditto and v. r. ..	£
Ullmann	240 & 480	Direct ..	6 B. & W., cond., clg. tr., 1 Boby heater	5 Musgrave horizontal	5 English Elec Mfg. Co.	1,275	690	.. ..	Fdrs., lead covd. in conduits, dist. Callender, solid ..	
Angus ..	200	50~, 1-ph.	2 Lanc.	2 Browett-Lindley, vert., open, 1 ditto, enclosed	2 J. & P., 1 Rosling	280	135	Pritchetts, 16 KW. for 9 hrs.	H.p. conc., Glover diatrine, and B.I W., l.p. twin, Callender, solid	
Newington	230	50~, 1-ph., & direct	34 marine, 4 water tube, with stokers	27 Willans, 4 Belliss	17 Siemens, 10 Mather & Platt, 4 Ferranti, 2 E.C.C.	10,477	7,174	3,600 amp.-hrs.	.. ..	£7
Foster ..	230 & 460	Direct ..	2 Lanc., econ., 1 dryback, Körting cond. and spray	2 Alley & MacLellan tandem comp. and 1 Belliss comp.	2 Laurence Scott, 1 Dick Kerr ..	150	..	Pritchetts & Gold	Callender, solid	£
L. Heath ..	3,000, 350, & 200	50~, 3-ph.	2 Lanc., cond.	3 Allen	3 International Elec. Eng.	350	85	.. ..	Lead covd., ppr., laid solid, h.p. armd., Callender ..	£
Munro ..	100	100~, 1-ph.	5 B. & W., 1 suphtr., feed htrs.	3 Fowler, 1 Easton, 1 Brush, 1 Hick Hargreaves, 2 Alley	4 Mordey, 1 Fynn, 1 Ferranti, 2 Thomson-Houston arc.	670	412	.. ..	Concentric	£
Millan ..	250	Direct ..	2 Dryback marine, feed heater & econ.	3 Belliss & Morcom	3 Mavor & Coulson	300	..	256 cells, 100 amp.-hrs. ..	Triple conc., vulc. bit. lead covd. in e'ware conduits ..	
ke ..	100	125~, 1-ph.	2 loco., 1 econ.	1 Ransome hot., 2 Browett-Lindley, 1 Peache, vert., all comp. cond.	2 Thomson-Houston, 1 Johnson-Phillips, A.C.; 2 T. H. arc.	140	63	.. ..	B I.W. twin and conc., and Okonite	£
Pember ..	220 & 440	Direct ..	3 Lanc., econ. and cond.	3 Browett-Lindley, 1 Belliss.. ..	3 Lanc. Dynamo Co., 1 Westinghouse	610	350	Tudor, 400 amp.-hrs.	B I.W. 5-core fdrs., 3-core dist., and Glover 3 single lead covd, solid in Howard conduit	£
nsom ..	200 & 400	Direct ..	2 B. & W., econ., destructor..	2 Willans	2 Johnson-Phillips	120	96	Chloride, 600 amp.-hrs. ..	Triple core and 3-core ppr. lead covd. and armd. ..	£
sketh ..	210 & 420	Direct ..	4 Paxman Economic, surf. cond. (oil burnt in two) 1 B. & W., suphtr.	6 Peache	6 Parker	1,180	650	Tudor, 170 KW. for 3 hrs. ..	Vulc bit. solid. triple conc. and 3-core armd. direct, Callender; dble. conc. solid for Hythe (4½ miles).	£1
d	150	Direct ..	.. ..	3 Gilkes turbines	2 Laurence Scott, 1 General Electric	118	120	E. P. S., 70 amp. for 9 hrs. ..	Overhead and underground, Glover dia. armd.	£
Perry ..	110	Direct ..	1 Dowson gas producer plant	2 Hercules water turbines, 1 Crossley gas eng ne	3 Statter, 2 Crompton, 1 Holmes, geared	153	84	Tudor, 24 KW. for 3 hrs. ..	Bare copper and diatrine single in bitumen	£
Chamen..	250 & 500	Direct ..	20 B. & W., 6 Marine, stokers, suphtrs., cond. ..	22 Willans, 4 Belliss, 1 Marine, 1 Ball & Wood	13 Siemens, 4 Crompton, 2 Westinghouse, 3 Peebles, 2 Walker, 2 Schuckert, 2 B. T. H.	19,200	7,550	Tudor, (1) 250 a. for 5 hrs., (2) 1,000 a. for 2 hrs.	Paper and bit. yarn conc. feeders: network, lead covd. and vulc bit. solid	£8
Knowles ..	240 & 480	Direct ..	2 Economic	3 Belliss	3 Parker	..	..	D. P., 400 amp.-hrs. 200 cells	Callender single, laid solid	
Bache ..	220 & 440	Direct ..	4 Lanc., stokers and econ.	2 Belliss, 1 Willans	4 Silvertown, 2 Mather & Platt ..	750	304	E. P. S., 1,000 amp.-hrs. ..	Triple conc., Callender, solid	£
Robertson	240	Direct ..	2 B. & W., chain grates, Boby feed heater ..	2 Belliss	2 Fowler..	200	85	D. P. Co., 350 amp. hrs. ..	Solid, in wood trough, for public lamps, 3-core lead covd. and armd., Callender.	
owell ..	200	Direct ..	1 Cornish	1 Thos. White, 1 Powis	1 Elwell Parker, 1 E. C. C.	60	20	.. ..	Overhead 2-wire, Henley	
Parsons ..	250 & 500	Direct ..	4 B. & W.	4 Belliss	2 B. T. H., 1 Silvertown, 1 Dick Kerr	610	462	Tudor, 160 amp. hrs.* ..	Single lead covd. and armd. direct	£
Milnes ..	240 & 480	Direct ..	2 Hornsby water tube, suphtr., Boby feed heater	2 Belliss, 3rd set about to be added	2 Parker	180	..	D. P., 260 cells, 600 amp.-hrs.	3 way solid and 3-core armd., Callender	
McInnes ..	230	Direct ..	3 B. & W., stokers, econ. and detart.	3 Alley & Macclellan	3 Lancashire Dynamo Co.	600	..	Verity, 500 amp.-hrs.	Western Electric lead covd., ppr. solid	£
Long ..	230 & 460	Direct ..	2 Lanc., destructor and Lanc. blr...	2 Reavell	2 British Schuckert	200	90	D.P., 17 KW. for 10 hrs ..	Triple conc. bit. armd., Callender	£
I. Nelson ..	250 & 500	Direct ..	6 B. & W., stokers, econ., surf. cond.	3 comp., 3 triple, Belliss	7 Silvertown	1,100	600	Tudor, 100 KW. for 4 hrs. ..	Vulc. bit., solid and in C.W. casing, Callender	£
Vignoles..	230	Direct ..	4 Lanc., 1 Stirling, econ., surf. cond. & clg. tr. ..	8 Belliss	8 Mather & Platt, 2 Westinghouse..	900	..	Tudor, 600 amp.-hrs.	Fdrs. conc., dist. triple conc., B.I.W. solid	£
Bird ..	210 & 420	Direct ..	4 B. & W., econ.	4 Belliss	4 Parker	510	230	D. P., 35 KW. for 5 hrs.; Tudor, 100 KW. for 5 hrs.	Fdrs. triple conc., armd., and 2-core solid; dist. 3-core armd. and solid, Callender	£
V. Money- nt	215	Direct ..	3 B. & W., stokers, surf. cond.	5 Willans	3 Jackson, 2 Rosling	200	..	Chloride, 300 amp.-hrs. ..	Callender, v. bit. and fibre, iron armd.	£
M. Rogerson	100, 230, & 460	25~, 3-ph. & direct	4 Lanc., 6 B. & W., stokers and econ.	3 Belliss vert. triple, 5 Pollit hor. comp., 2 Parsons turbines	8 E. C. C., 2 Parsons	3,200	2,143	Chloride, 150 KW. for 6 hrs.	V. r. Siemens, v. bit. and lead covd. ppr., Callender ..	£2
Cowell ..	100 & 200	100~, 1-ph.	8 Lanc , econ.	6 Brush, 2 Ferranti	4 Mordey, 2 Ferranti A.C., 2 Brush arc	1,214	677	.. ..	H. p. v. r. and ppr., l.p. Callender single, and B.I.W...	£
Ilkinson ..	100 & 200	50~, 1-ph.	5 Lanc., stokers, econ., suphtrs.	4 M'Laren (2 comp., 2 triple) vert., 1 Parsons turbine	3 Ferranti, 1 Siemens, 1 Parsons ..	1,150	660	.. ..	Conc , ppr., lead covd., B.I.W. and Siemens	£
Hill ..	220 & 440	Direct ..	4 B. & W., econ.	6 Willans	4 Crompton, 1 Mather & Platt, 1 Siemens	535	250	E. P. S.	Bare cpr., and Callender in ducts and solid	£
ll F. Fer- son	200	100~, 1-ph.	5 B. & W., econ., surf. cond. & clg. tr.	3 Brush, 2 Belliss, 1 Parsons turbine, 1 Peache	5 Brush, 1 Parsons, 1 Crompton ..	1,235	602	Tudor, 65 KW. hrs.	Paper, diatrine, Glover	£1
r V. Rye ..	240 & 480	Direct ..	2 B. & W.	3 Belliss	2 Parker	180	88	D. P., 400 amp.-hrs.	Vulc. bit., laid solid in wood trough, Callender.. ..	
Vesey Brown	230 & 460	Direct ..	2 B. & W.	2 Allen	2 Crompton	400	..	232 Chloride, 500 amp.-hrs...	Callender, single, laid solid	
Fairweather										
Carter ..	230	Direct ..	2 Stewart, 1 B. & W., 1 Stirling, suphtrs., econ.	3 Reavell, 1 Howden, vert. comp. ..	2 Fowler, 1 Dick Kerr	380	115	Tudor, 350 amp.-hrs.; Chloride, 350 amp. hrs.	Ppr., solid, Henley	£
Poulton ..	220 & 440	Direct ..	2 Lanc., econ., atmo. cond.	3 Belliss (2 comp., 1 triple)	3 Silvertown	450	147	Chloride, 660 amp.-hrs. ..	V. r. in bit., Silvertown	£
Btott ..	200 & 400	Direct ..	2 Lanc., econ.	2 Reavell vert. comp.	2 Crompton	120	41	Marquand, 300 amp.-hrs. ..	V. bit. and ppr., lead covd., solid	£
Brandreth	210 & 420	Direct ..	4 Paxman Economic, 1 Sugden feed htr., 1 B. & W. fired suphtr., cond.	4 Peache, 1 Belliss	5 Parker	820	380	Tudor, 120 KW. for 3 hrs. ..	Fdrs. conc., dist. 3-core, all armd. direct, Callender ..	£
ainland ..	240 & 480	Direct ..	3 dryback	2 Browett-Lindley	2 Mather & Platt	600	250	292 E. P. S., 1,200 amp.-hrs.	Siemens, triple conc., ppr., lead covd. armd. & laid solid	£
Smith ..	220	Direct ..	2 Lanc., 5 B. & W., econ.	9 Willans, 1 Belliss	10 Crompton	1,203	751	Tudor, 127 KW.	Bare cpr. in ducts, insd. cable in iron pipes	£15
M'Haffie..	230	50~, 1-ph.	3 Lanc., econ. and suphtr.	4 Belliss	4 Crompton	375	154	Chloride, 24 KW. for 5 hrs...	Fibre, conc. solid, Callender	£

110 CRIMSBY	Corporation	1901	W. A. Vignoles..	230	Direct ..	4 Lanc., 1 Stirling, econ., surf. cond. & clg. tr. ..	8 Belliss	8 Mather & Platt, 2

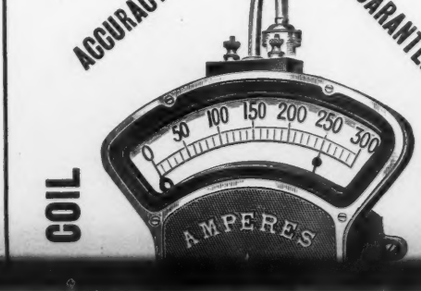
10 Crompton	1,208	751	Tudor, 127 KW.	Siemens, triple conc., ppr., lead covd. armd. & laid solid	£73,335	12,000	..	50 arc. ..	2=3 H.P. ..	Ltg. 7d. & 2d., pr. 4d. & 1d.							
				Bare cpr. in ducts, insd. cable in iron pipes	£127,103												

Direct ..	3 dryback	2 Browett-Lindley	2 Mather & Platt	600	250	392 E. P. S., 1,200 amp.-hrs.	Siemens, triple conc., gpr., teak covd. armd. & lead covd.					
Direct ..	2 Lanc., 5 B. & W., econ.	9 Willans, 1 Belliss	10 Crompton	1,208	751	Tudor, 127 KW.	Bare cpr. in ducts, insd. cable in iron pipes					
50~, 1-ph.	3 Lanc., econ. and suphtr.	4 Belliss	4 Crompton	375	154	Chloride, 24 KW. for 5 hrs...	Fibre, conc. solid, Callender					

110	CRIMSBY	Corporation	1901	W. A. Vignoles..	.. 230	Direct ..	4 Lanc., 1 Stirling, econ., surf. cond. & clg. tr. ..	8 Belliss	8 Mather & Pla			
111	CUERNSEY	G. Electricity Supply Co.	1900	A. G. Bird ..	210 & 420	Direct ..	4 B. & W., econ.	4 Belliss	4 Parker			
112	CUILDFORD	G. Electricity Supply Co.	1896	J. M. V. Money-Kent	215	Direct ..	3 B. & W., stokers, surf. cond.	5 Willans	3 Jackson, 2 Ro			
113	HALIFAX	Corporation	1892	W. M. Rogerson	100, 230, & 460	25~, 3-ph. & direct	4 Lanc., 6 B. & W., stokers and econ.	3 Belliss vert. triple, 5 Pollit hor. comp., 2 Parsons turbines	8 E. C. C., 2 Pa			
114	HANLEY	Corporation	1894	C. A. Cowell ..	100 & 200	100~, 1-ph.	8 Lanc , econ.	6 Brush, 2 Ferranti	4 Mordey, 2 F arc			
115	HARROCATE	Corporation	1897	G. Wilkinson ..	100 & 200	50~, 1-ph.	5 Lanc., stokers, econ., suphtrs.	4 M'Laren (2 comp., 2 triple) vert., 1 Parsons turbine	3 Ferranti, 1 Si			
116	HARROW	H. Elec. Light & Power Co.	1896	E. B. Hill ..	220 & 440	Direct ..	4 B. & W., econ.	6 Willans	4 Crompton, 1 Siemens			
117	HASTINGS	Corporation	1883	Russell F. Ferguson	200	100~, 1-ph.	5 B. & W., econ., surf. cond. & clg. tr.	3 Brush, 2 Belliss, 1 Parsons turbine, 1 Peache	5 Brush, 1 Par			
118	HAWICK	Urban Electric Supply Co.	1902	Arthur V. Rye ..	240 & 480	Direct ..	2 B. & W.	2 Belliss	2 Parker			
119	HEBBURN	Northern Counties Elec. Supply Co.	1903	C. S. Vesey Brown C. W. Fairweather	230 & 460	Direct ..	2 B. & W.	2 Allen	2 Crompton			
120	HECKMONDWIKE ..	Urban District Council	1901	G. H. Carter ..	230	Direct ..	2 Stewart, 1 B. & W., 1 Stirling, suphtrs., econ.	3 Reavell, 1 Howden, vert. comp. ..	2 Fowler, 1 Dic			
121	HEREFORD	Corporation	1899	F. G. Poulton ..	220 & 440	Direct ..	2 Lanc., econ., atmo. cond.	3 Belliss (2 comp., 1 triple)	3 Silvertown			
122	HEYWOOD	Corporation	1900	Jas. Stott ..	200 & 400	Direct ..	2 Lanc., econ.	2 Reavell vert. comp.	2 Crompton			
123	HICH WYCOMBE ..	Wycombe (Borough) E. L. & P. Co.	1898	W. E. Brandreth	210 & 420	Direct ..	4 Paxman Economic, 1 Sugden feed htr., 1 B. & W. fired suphtr., cond.	4 Peache, 1 Belliss	5 Parker			
124	HORNSEY	Urban District Council	1902	N. Stainland ..	240 & 480	Direct ..	3 dryback	2 Browett-Lindley	2 Mather & Pla			
125	HOVE	Hove Electric Lighting Co.	1892	C. B. Smith ..	230	Direct ..	2 Lanc., 5 B. & W., econ.	9 Willans, 1 Belliss	10 Crompton			
126	HOYLAKE & W. KIRBY	Urban District Council	1901	H. G. M'Haffie..	230	50~, 1-ph.	3 Lanc., econ. and suphtr.	4 Belliss	4 Crompton			
127	HUDDERSFIELD ..	Corporation	1893	A. B. Mountain	100 & 200	100~, 1-ph.	11 Lanc., 6 B. & W., stokers and econ.	3 Brush, 1 Universal; 2 McLaren, 2 Ferranti	4 Mordey, 2 Fe			
128	HULL	Corporation	1893	H. Bell (acting)	110 & 220	Direct ..	12 Lanc.	6 Willans, 5 Allen, 2 Browett-Lindley	2 Holmes, 11 P			
129	ILFORD	Urban District Council	1901	A. H. Shaw ..	230 & 460	Direct ..	4 B. & W., 2 dryback, suphtrs. and econ... ..	5 Willans	3 G. E. Co., 2 I			
130	ILKESTON	Corporation	1903	C. O. Pilcher ..	230 & 460	Direct ..		Bulk supply from Derby and Notts. Electric Power Co.				
131	INCLETON	I. Elec. Lighting & Power Co. ..	1900	J. Gould.. ..	100 & 200	Direct ..	.. ..	2 Turbines	2 J. P. Hall			
132	IPSWICH	Corporation	1903	.. .. ..	230	Direct ..	4 dryback	4 Reavell (2 ltg., 2 ltg. & tr.) ..	4 A. E. G.			
133	JARROW	County of Durham El. Pr. Dist. Co...	1902	W. E. Tooth ..	230 & 460	.. ..	2 B. & W. marine, 1 Fraser dryback	4 Universal	4 Brush..			
134	KEIGHLEY	Corporation	1901	J. M. Smyth ..	230 & 460	Direct ..	2 Lanc., stokers, econ., ejector cond.	3 Allen, vert. comp.	3 Parker..			
135	KENDAL	Corporation	1902	T. N. Ritson ..	220 & 440	Direct ..	Fraser's Economic	2 Willans	2 Johnson & P			
136	KESWICK	K. Electric Light Co., Ltd.	1890	.. .. ..	100	75~, 1-ph.	1 Lanc.	1 Westinghouse, 1 Victor turbine ..	2 Kapp ..			
137	KIDDERMINSTER ..	K. and Dist. Elec. Ltg. and Tr. Co...	1900	W. Griffiths ..	230 & 460	Direct ..	5 B. & W., Wilson smokeless process and econ.	3 Brush, 2 Parsons turbine	3 Mordey, 2 Pa			
138	KILLARNEY	Killarney Electric Lighting Co. ..	1893	L. C. Trevor-Roper	100	100~, 1-ph.	1 loco-type, jet cond.	1 Fowler hor. comp 1 turbine, 1 water-wheel	2 Mordey, 1 Fe			
139	KINC'S LYNN	Corporation	1899	J. Pilling ..	200 & 400	Direct ..	2 Lanc., econ., jet cond., 2 vert. for producer plant.	2 Belliss (steam), 5 Fielding & Platt (gas)	2 Laurence Sco			
140	KIRKCALDY	Corporation	1903	O. F. Francis ..	230 & 460	Direct ..	3 Stirling	5 Browett-Lindley	5 Laurence Sco			
141	KINGSTON-UPON-THAMES	Corporation	1893	J. E. Edgcome..	105	77~, 1-ph.	3 Lanc., 4 B. & W., stokers, suphtrs., surf. cond., econ.	10 Belliss	10 Siemens			
142	LANCASTER	Corporation	1894	W. A. Tester ..	100 & 200	Direct ..	5 Lanc., 2 Lancs., & destctor.	4 Willans, 1 Westinghouse, 4 Belliss	3 Brush, 1 Mat inghouse			
143	LARNE	L. Electric Lighting Works.. ..	1892	M. G. Smyth ..	100 & 200	100~, 1-ph.	2 Cornish induced draught	2 Combe Barbour hor. cond. ..	2 Mordey ..			
144	LEAMINGTON	Midland Elec. Lt. & Pr. Co... ..	1887	F. W. E. Jones	115 & 230	Direct ..	3 Robey loco., cond.	3 Robey comp...	5 Chamberlain			
145	LEEDS	Corporation	1893	H. Dickinson ..	100 & 200	83~, 1-ph., 50~, 2-ph.	14 Lanc., 10 B. & W., stokers, econ., suphtrs. and cond.	1 Fowler, 2 Hick-Hargreaves, 12 Belliss, 1 McLaren	4 Ferranti, 9 E.			
146	LEICESTER	Corporation	1894	A. Colson ..	100 & 200	50~, 1-ph.	6 B. & W., 5 Lanc.	6 Hick Hargreaves, horiz.	4 Ganz, 2 Brush			
147	LEICH	Corporation	1899	B. M. Kinghorn	220 & 440	Direct ..	2 Lanc., & 1 water tube	2 Willans, 1 Galloway	4 Mather & Plat			
148	LEITH	Corporation	1899	A. P. Rutherford	230 & 460	Direct ..	4 Lanc., econ.	7 Belliss	7 Silvertown			
149	LEWES	Lew s & Dis. Elec. Supply Co. ..	1901	W. F. Bolton ..	230 & 460	Direct ..	3 B. & W., suphtrs, jet. cond., feed htr.	2 Universal vert. comp., 1 Allen ..	3 Mordey			
150	LEYTON	Urban District Council	1896	F. H. Lewis ..	150 & 300	Direct ..	8 Paxman, econ.	6 Willans	5 Mather & Plat			
151	LIMAVADY	L. Power and Light Works	1897	E. J. S. Ritter ..	110 & 220	100~, 1-ph.	.. ..	Turbines	4 Siemens			
152	LIMERICK	Corporation	1902	.. .. ..	230 & 460	Direct ..	.. ..	3 Westinghouse gas engines.. ..	3 A. E. G.			
153	LINCOLN	Corporation	1898	S. Clegg	230	Direct ..	5 Marine, econ., water softener	6 Willans	7 Laurence Scot			
154	LIVERPOOL	Corporation	1883	A. Clough (Res.)	230 & 460	Direct ..	73 Lanc., stokers, 6 econ.	63 Willans	66 Siemens & E			
155	LIVERPOOL DISTRICT*	Liverpool District Lighting Co. ..	1887	W. M. Horsfall..	220	Direct ..	3 Lanc., stokers, feed htr.	3 Willans, 2 Browett-Lindley ..	3 Parker, 1 Siem			
156	LLANDILO	Urban District Council	1902	.. .. ..	230 (2-wire)	Direct ..	1 Cornish	1 Browett-Lindley	1 Bertram Thor			
157	LLANDRINDOD WELLS	L. W. Electric Light & Power Co...	1897	A. H. Sears ..	230 & 460	Direct ..	3 Lanc.	1 Willans, 1 Alley & MacLellan, 1 Reavell	1 Siemens, 1 Bertram Thor			
158	LLANDUDNO	Urban District Council	1898	H. Morton ..	220 & 440	Direct ..	6 B. & W. (2 combined Beaman & Deas destructor) econ.	3 Belliss, 3 Allen, vert. comp. ..	4 Silvertown, 2			
159	LONDONDERRY ..	Corporation	1894	R. V. Macrory ..	2,150 to 2,500	Direct ..	2 Lanc., econ., cond.	3 Brown & Sons, vert. comp. ..	6 Siemens arc. .			
160	LONGTON	Corporation	1901	W. Langford ..	230 & 460	Direct ..	2 B. & W., econ.	2 Belliss..	2 E. C. C.			
161	LOWESTOFT	Corporation	1901	G. A. Bruce ..	230 & 460	Direct ..	4 B. & W., suphtrs., surf. cond.	2 Musgrave, 2 Browett-Lindley ..	3 B. T. H., 1 La			
162	LUTON	Corporat.on	1901	W. H. Cooke ..	250 & 500	Direct ..	2 Lanc., sf. cond., econ., suphtr., water softener	4 Allen vert. comp.	5 Allen ..			
163	LYMINGTON	L. Electric Light & Power Co. ..	1900	Glynn Salter ..	240 & 480	Direct ..	2 B. & W., suphtrs.	2 Belliss..	2 Parker			
164	LYNTON & LYNMOUTH	Lynton & Lynmouth E. L. Co. ..	1889	P. T. Kimmins	100	100~, 1-ph.	1 loco.	1 Sherman (steam), 1 Escher Wyss, 5 Pelton (water)	2 Mordey, 1 E. C			
165	MACROOM	M. & Dist. Elec. Ltg. Syndicate ..	1898	L. O'Connor ..	2,900	100~, 1-ph.	*	1 portable, Clayton & Shuttleworth, 1 turbine	1 Mordey			
166	MAIDSTONE	Corporation	1901	E. E. Hoadley ..	230 & 460	Direct ..	4 Paxman dryback	5 Peache	5 Parker			
167	MANCHESTER	Corporation	1893	G. F. Metzger ..	100, 200, & 400	Direct .. Direct .. 50~, 3-ph. 6,500 volts	*Dickinson Street* :—18 Lanc., 4 B. & W., stokers, jet. cond., econ. *Bloom Street* :—11 B. & W., stokers, surf. cond., econ. *Stuart Street* :— B. & W., stokers, jet and surf. cond., clg. trs., econ.	4 Galloway, 5 Goodfellow, 2 Musgrave, 2 Ferranti, 2 Parsons turbo. 4 Musgrave .. .. 6 Yates & Thom, 2 Wallsend Slipway, 3 Willans	6 Mather & Pla mens, 2 Westi 4 Westinghouse 11 Electrical Co.			
168	MANSFIELD	Corporation	1903	E. Holcombe Hewlett	240	Direct ..	3 Lanc., 2 water-tube, econ., Proctor stokers, Ledward ejector cond., forced draught	Alley & McLellan, triple exp. dble. acting	2 Parker..			
169	MARCATE & BROADSTAIRS	I. of Thanet Elec. Tram. & Ltg. Co.	1901	R. Humphries ..	240 & 480	Direct ..	4 B. & W., econ.	2 Allis hor., 2 Belliss vert.	4 B. T. H.			
170	MARKET DRAYTON ..	The Market Drayton Elec. Lt. & Pr. Co., Ltd.	1902	C. W. Bentley ..	210	.. ..	1 Davey Paxman loco., Boby heater	2 Belliss..	2 Parker..			
171	MELTON MOWBRAY ..	M. M. Electric Light Co.	1900	W. H. Russell ..	240 & 480	Direct ..	3 B. & W., suphtrs., stokers, econ., ejector cond.	3 Parsons turbines	3 Parsons			
172	MERTHYR TYDFIL ..	M. Elec. Traction and Ltg. Co. ..	1901	A. L. Plunket ..	230 & 460	Direct ..	4 B. & W., surf. cond.	4 Browett-Lindley vert. comp. ..	3 Peebles, 1 Silv			
173	MEVACISSEY	M. Electric Light. Co.	1893	J. G. Hill ..	110	Direct ..	1 Paxman	Paxman under-type engine	1 Crompton			
174	MEXBOROUCH	Urban District Council	1902	H. Waring ..	220	Direct ..	2 Lanc., feed heaters	2 Alley & Maclellan, 1 Belliss ..	3 Mavor & Coul			

~ = cycles per second.

CONSTANT **E.M.F.** GUARANTEED.
ON
TRACTION AND LIGHTING LOADS
BY THE USE OF THE
HIGHFIELD
AUTOMATIC REVERSIBLE
BOOSTER
WITH A



SULPHURIC ACI
SPECIALLY PREPARED
FOR
ACCUMULATOR

00	Direct ..	6 B. & W., stokers, econ., surf. cond.	3 comp., 3 triple, Belliss	7 Silvertown	1,100	600	Tudor, 100 KW. for 4 hrs. ..	Vulc. bit., solid and in C.W. casing, Callender ..				
	Direct ..	4 Lanc., 1 Stirling, econ., surf. cond. & clg. tr. ..	8 Belliss	8 Mather & Platt, 2 Westinghouse..	900	..	Tudor, 600 amp.-hrs.	Fdrs. conc., dist. triple conc., B.L.W. solid ..				
20	Direct ..	4 B. & W., econ.	4 Belliss	4 Parker	510	230	D. P., 35 KW. for 5 hrs.; Tudor, 100 KW. for 5 hrs.	Fdrs. triple conc., armd., and 2-core solid; 3-core armd. and solid, Callender				
	Direct ..	3 B. & W., stokers, surf. cond.	5 Willans	3 Jackson, 2 Rosling	200	..	Chloride, 300 amp.-hrs.	Callender, v. bit. and fibre, iron armd.				

iron pipes	£127,103	69,882	8,434	..	50=141 K.W. ..	Ltg. 7d. & 4d., pr. 8d.	Max. demand	735,816	5.49	1.85	2.45								
.. ..	£43,000	18,000	6,000	252 lamps= 574 8 c. p.	4=2 H.P. ..	Ltg. 7d. & 3d. or 5½d. pr. 3d. & 1½d.	Max. demand & flat rate	155,273	4.4	3	..								

25 KW. motor alternator for charging batteries and taking day load. 126

127

..	8 Mather & Platt, 2 Westinghouse..	900	..	Tudor, 600 amp.-hrs.	Fdrs. conc., dist. triple conc., B.I.W. solid	£72,000	21,334	8,273	80 arc ..	16=45 H.P...	Ltg. 4½d., pr. 2½d. to 1½d.	Flat rate ..	653,438	2.5					
..	4 Parker	510	230	D. P., 35 KW. for 5 hrs.; Tudor, 100 KW. for 5 hrs.	Fdrs. triple conc., armd., and 2-core solid; dist. 3-core armd. and solid, Callender	£90,696	30,047	19,198	12 inc. ..	552 H.P. ..	Ltg. 7d. & 3d., pr. 4d. & 1½d. or 2½d.	Max. demand & flat rate	182,223	4.0					
..	3 Jackson, 2 Rosling	200	..	Chloride, 300 amp.-hrs. ..	Callender, v. bit. and fibre, iron armd.	£26,855	8,000	2,000	..	..	Ltg. 6d., pr. 3d.	Flat rate ..	..	..					
it hor.	8 E. C. C., 2 Parsons	3,200	2,143	Chloride, 150 KW. for 6 hrs.	V. r. Siemens, v. bit. and lead covd. ppr., Callender ..	£212,579	80,172	10,272	69 arc, 100 inc	77=294 H.P.	Ltg. 4d., pr. 2d. ..	Flat rate ..	3,187,369	2.1					
..	4 Mordey, 2 Ferranti A.C., 2 Brush arc	1,214	677	.. ..	H. p. v. r. and ppr., l.p. Callender single, and B.I.W...	£78,330	44,973	4,549	68 arc, 191 inc.	36=90 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d.	Max. demand	..	..					
) vert.,	3 Ferranti, 1 Siemens, 1 Parsons ..	1,150	660	.. ..	Conc., p.r., lead covd., B.I.W. and Siemens	£92,200	45,190	7,995	60 arc, 170 inc.	36=130 H.P.	Ltg. 6d., 4d., 3d. or 6d. & 2d., pr. 2d.	Max. demand	761,136	4.7					
..	4 Crompton, 1 Mather & Platt, 1 Siemens	535	250	E. P. S.	Bare cpr., and Callender in ducts and solid	£56,892	18,000	..	..	14=55 H.P.	Ltg. 8d. & 4d., pr. 4d.	Max. demand & flat rate	..	..					
ns tur-	5 Brush, 1 Parsons, 1 Crompton ..	1,235	602	Tudor, 65 KW. hrs.	Paper, diatrine, Glover	£128,944	33,443	4,015	104 arc ..	7=8 H.P....	6d., or 10s. per an. per 1p. & 1½d. per u.	Flat rate & Hopkinson	803,761	Priv. 5 Pub. 3.					
..	2 Parker	180	88	D. P., 400 amp.-hrs.	Vulc. bit., laid solid in wood trough, Callender.. ..	..	7,319	..	10 arc, 103 inc.	10=37 H.P.	Ltg. 7d. & 3d., pr. 4d. & 1½d.	Max. demand	38,695	4.1					
..	2 Crompton	400	..	232 Chloride, 500 amp.-hrs...	Callender, single, laid solid	..	..	..	10 arc, 150 inc	..	Ltg. 4½d., pr. 2d. to 1½d.	Flat rate & sliding scale	..	..					
mp. ..	2 Fowler, 1 Dick Kerr	380	115	Tudor, 350 amp.-hrs.; Chloride, 350 amp. hrs.	Ppr., solid, Henley	£20,000	7,285	1,982	10 arc, 224 inc.	10=36 H.P...	Ltg. 6d. & 3d. or 5d., pr. 2d. or 1d.	Max. demand & flat rate	73,631	Pri. 4.3 Pub 2.					
..	3 Silvertown	450	147	Chloride, 660 amp.-hrs. ..	V. r. in bit., Silvertown	£25,239	9,372	1,115	..	13=42 H.P...	Ltg. 6d & 4d., pr. 3d. & 2d.	Max. demand	108,815	4.8					
..	2 Crompton	120	41	Marquand, 300 amp.-hrs. ..	V. bit. and ppr., lead covd., solid	£15,000	3,380	..	4 arc.. ..	13=64 H.P. .	Ltg. 6d. & 3d., pr. 2½d. & 1½d.	Accdg. to lps. installed ..	39,679	4.2					
..	5 Parker	820	380	Tudor, 120 KW. for 3 hrs. ..	Fdrs. conc., dist. 3-core, all armd. direct, Callender ..	£60,000	28,037	6,020	10 arc, 238 inc.	..	Ltg. 5d. & 2d., pr. 4d. & 1d.	Max. demand	403,750	3.4					
..	2 Mather & Platt	600	250	232 E. P. S., 1,200 amp.-hrs.	Siemens, triple conc., ppr., lead covd. armd. & laid solid	£73,335	12,000	..	50 arc. ..	2=3 H.P. ..	Ltg. 7d. & 2d., pr. 2½d.	Max. demand & flat rate	..	..					
..	10 Crompton	1,208	751	Tudor, 127 KW.	Bare cpr. in ducts, insd. cable in iron pipes	£127,103	69,882	8,434	..	50=141 K.W.	Ltg. 7d. & 4d., pr. 8d.	Max. demand	735,916	5.4					
..	4 Crompton	375	154	Chloride, 24 KW. for 5 hrs...	Fibre, conc. solid, Callender	£43,000	18,000	6,000	252 lamps= 574 8 c. p.	4=2 H.P. ..	Ltg. 7d. & 3d. or 5½d. pr. 3d. & 1½d.	Max. demand & flat rate	155,273	4.4					
Laren,	4 Mordey, 2 Ferranti, 2 Siemen ..	3,290	1,415	.. ..	B.I.W. armd. conc. and Callender, solid..	£164,596	113,921	13,187	38 arc, 48 inc.	103=436 H.P.	Ltg. 4½d., pr. 2½d. & 1d.	Flat rate ..	1,298,255	3.8					
Lindley	2 Holmes, 11 Parker	4,030	2,735	Pritchetts & Gold, 600 amp.-hrs.	Bare cpr., Callender bit. and Siemens armd. dist., Siemens conc. fdr. in ducts.	£252,546	192,453	62,123	12 arc ..	234=1959 H.P.	Ltg. 5d. & 3d. or 4½d., pr 2d. to 1d.	Max. demand fl. r. & s. c.	2,385,577	3.8					
..	3 G. E. Co., 2 Dick Kerr	1,600	805	E. P. S., 600 amp.-hrs. ..	Conc. armd. fdrs., solid dist., Henley	£76,000	33,230	19,311	44 arc, 807 inc	28=137 H.P.	8d. & 2d. or 5d. ..	Max. demand or flat rate	772,188	..					
Electric	Power Co.	..	..	.. ..	Callender, laid solid	..	..	..	..	..	Ltg. 4½d.. pr. 3d...	Flat rate ..	..	..					
..	2 J. P. Hall	20	16	D. P., 27 H.	Callender, 2 and 3 core lead covd. and armd. direct														
..	4 A. E. G.	690	..	400 amp.-hrs.	Ppr., lead covd., solid in wood, Johnson & Phillips ..	..	..	..	..	..	Ltg. 6d. to 4½d., pr. 2d. to 1½d.	Flat rate with discount ..	..	..					
..	4 Brush..	300	66	420 amp.-hrs., 280 amp. max.	Fdrs. triple conc., dist. 3-core, solid	..	3,069	887	..	8=17 H.P. ..	Ltg. 7d. & 1d., pr. 4d. & 1½d.	Max. demand	..	..					
..	3 Parker..	440	140	Tudor, 35 KW. for 10 hrs. ..	Jute, lead covd., & vulc. bit., single, Callender solid ..	£38,000	8,000	2,300	24 arc, 48 inc.	30=124 H.P.	Ltg. 7d. & 3d. or 5d., pr. 2½d. to 1½d.	Max. demand & flat rate	139,000	3.4					
..	2 Johnson & Phillips..	72	..	Tudor, 20 KW. for 5 hrs. ..	Triple conc., B.I.W.	..		Not yet completed			6d. & 3d.	Flat rate ..	..	..					
bine ..	2 Kapp	60	..	.. ..	V. r. underground and overhead	..	..	..	..	..	6d.	Flat rate ..	..	..					
..	3 Mordey, 2 Parsons	1,050	..	Chloride, & Pollak, 750 amp.-hrs.	Armd., lead covd., conc.; sep. power cables, 3-core lead covd., solid, B.I.W.	..	..	..	..	..	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand with disc.	343,594	..					
urbine,	2 Mordey, 1 Ferranti	169	79	.. ..	Callender and St. Helens armd. conc. fdrs., Callender lead covd. conc. dist.	..	3,200	..	3 inc. ..	..	5d.	Contract & flat rate	..	..					
& Platt	2 Laurence Scott, 5 G. E. Co. ..	520	250	Chloride, 30 KW. for 5 hrs. ..	Fdrs. jute, conc. lead covd. in ducts. & armd. direct; dist., triple conc. armd. direct, ppr. B.I.W. solid	£45,081	15,212	3,202	22 arc, 470 inc.	25=109 H.P.	Ltg. 5d. & 4½d., pr. 3d. & 1½d.	Flat rate ..	923,175	3.2					
..	5 Laurence Scott	690	300	80 amps. 5 hrs., 120 amps. 3 hrs.	Henley single lead covd. solid in wood	£50,000	4,050	4,050	100 arc ..	11=23 H.P.	Ltg. 5½d., pr. 2½d.	Flat rate with disc.	..	..					
..	10 Siemens	630	332	.. ..	Armd. conc. Siemens laid direct	£82,784	25,767	2,882	76 arc ..	7=20 H.P....	Ltg. 6d. & 3d., pr. 3d. & 2d.	Max. demand & flat rate	392,962	5.0					
Belliss	3 Brush, 1 Mather & Platt, 5 Westinghouse	1,200	630	.. ..	Callender	£55,195	31,640	3,625	34 arc, 68 inc.	46=100 H.P.	Ltg. 5d., pr. 2d. ..	Flat rate ..	393,960	4.2					
..	2 Mordey	80	60	.. ..	B.I.W. armd. direct and solid, and bare copper.. ..	..	2,200	..	14 arc, 125 inc	.	2d. to 8d.	Contract & meters	..	..					
..	5 Chamberlain & Hookham	350	151	E. P. S. 1,000 a.-h., Hart 1,500 a.-h.	Jute, lead covd., fdrs. armd., dist. solid, Callender ..	..	13,810	3,692	..	11=19½ H.P.	Ltg. 7d. & 3½d. or 6d., pr. 4d.	M. d., Hop. & flat rate*	..	..					
es, 12	4 Ferranti, 9 E. C. C., 3 Fowler ..	8,740	4,126	.. ..	B.I.W., Henley and Silvertown	£328,098	194,114	53,312	93 arc ..	382=1,437 H.P	Ltg. 4d., pr. 1½d. to 2d.	Ltg. flat rate, pr. max. dem.	4,448,650	3.6					
..	4 Ganz, 2 Brush	3,400	1,789	.. ..	Paper conc.	£216,282	130,163	28,302	..	72=192 H.P.	Ltg. 4d., pr. 2d. ..	Flat rate ..	1,425,713	3.8					
..	4 Mather & Platt	250	264	Chloride, 150 KW. for 1 hr. ..	Triple conc., B.I.W., Johnson & Phillips, and Anchor Cable Co.	£22,000	11,875	2,472	.. ..	75=532½ H.P	Ltg. 7d. & 2½d. or 5d., pr. 3d. & ½d.	Max. demand & flat rate	344,898	2.8					
..	7 Silvertown	1,000	546	E. P. S. 750 amp.-hrs. ..	Triple conc., ppr., direct with steel plates, and solid in wood	£70,000	35,117	8,685	223 arc ..	78=416 H.P.	Ltg. 4d., pr. 1½d..	Flat rate with disc.	..	..					
en ..	3 Mordey	210	78.5	Hart, 10 KW. for 6 hrs. ..	Western Electric solid	£22,677	4,638	1,638	..	5=18½ H.P.	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand	42,842	5.2					
..	5 Mather & Platt, 1 A. E. G. ..	1,572	779	123 KW. for 4 hrs.	Armd. conc., also lead covd. in ducts for dist.	£125,000	40,248	7,444	72 arc, 529 inc.	20=42½ H.P.	Ltg. 5d. & 2d., pr. 5d. & 1d.	Max. demand	1,005,057	3.8					
..	4 Siemens	240	35	.. ..	Bare copper	..	1,000	50	..	..	10s. per 8 c.p. ..	Contract ..	..	..					
..	3 A. E. G.	..	..	.. ..	Fdrs. conc., dist. single, laid solid..	..	..	..	..	..	Ltg. 5d., pr. 2d. ..	Flat rate ..	..	..					
..	7 Laurence Scott	728	331	Chloride, 300 amp.-hrs. ..	V. bit. armd., conc. and triple conc., Callender	£35,550	20,960	3,931	30 arc, 107 inc.	39=79 H.P....	Ltg. 6d. & 2½d., pr. 4d. & 1½d.	Max. demand & flat rate	339,626	..					
..	66 Siemens & E. C. C.	21,190	10,589	K. L. P. type, E. P. S. ..	Callender solid..	£1,336,709	441,848	79,868	174 arc, 56 inc.	827=2,877 H.P.	Ltg. 3½d. & 3d., pr. 2d. & 1½d., tr. 1.2d.	Sliding scale	23,186,083	1.1					
..	3 Parker, 1 Siemens, 1 Robinson ..	348	234	E. P. S., 35 KW. for 4 hrs. ..	Callender solid..	£46,000	21,032	3,752	18 inc., 4 Nernst.	3=5 H.P. ..	Ltg. 5d., pr. 3d. ..	Flat rate ..	162,468	5.5					
..	1 Bertram Thomas	50	..	.. ..	Glover, lead covd. and armd. direct	..	..	..	..	..	Ltg. 6d., pr. 4d. ..	Flat rate ..	..	..					
lan, 1	1 Siemens, 1 Mather & Platt, 1 Bertram Thomas	240	..	.. ..	Glover conc. and single, B.I.W. & Helsby 2-core, armd. direct	..	..	..	..	..	Ltg. 6d., pr. 6d. to 3½d.	Flat rate and scale	..	..					
..	4 Silvertown, 2 Crompton	700	412	Pritchetts & Gold, 500 amp.-hrs.	Triple conc. fdrs., armd., lead cov., 3-core dist. direct..	£35,199	16,000	..	48 arc ..	12=75 H.P.	Ltg. 7d. & 2d. or 5d., pr. 2d.	Max. demand & flat rate	309,200	4.1					
..	6 Siemens arc..	150	93.5	.. ..	V. r. single core armoured	£19,786	..	..	183 arc ..	..	..	..	..	..					
..	2 E. C. C.	300	64	Chloride 40 KW. for 13 hrs. ..	Vulc. bitumen, solid	£20,992	4,336	2,803	..	14=21½ H.P.	Ltg. 8d. & 2d., pr. 2½d.	Max. demand	58,846 (inc. works)	5					
..	3 B. T. H., 1 Lanc. Dynamo Co. ..	975	275	Chloride..	V. r. conc. fdrs. and dist., Callender, solid	£58,000	18,274	6,779	70 arc, 233 inc.	13=46 H.P.	Ltg. 7d. & 3d., pr. 2½d.	Max. demand	276,482	5					
..	5 Allen	297	128	Chloride, 280 cells, 400 amp.-hrs.	Callender, v. bit. 3-core dist., conc. fdrs. & sing. core diable v. b.	£28,103	6,737	2,717	10 arc, 27 inc.	11=38 H.P.	Ltg. 6d. & 3d., or 4½d., pr. 2d. & 1½d.	Max. demand & flat rate	92,690	4.1					
..	2 Parker	124	107*	Tudor, 20 KW. for 8 hrs. ..	Callender, triple conc. fdrs., 3-core dist., all armd. ..	£23,000	5,747	2,244	2 arc, 108 inc.	4=6½ H.P....	Ltg. 7d. & 4d., pr. 4d. & 1½d.	Max. demand	65,594	4.8					
Wyse,	2 Mordey, 1 E. C. C.	150	54	.. ..	Diatrine twin and conc., Glover and St. Helens.. ..	£7,500	2,250	400	1 arc, 84 inc.	..	5d.	Flat rate ..	80,491	..					
orth,*	1 Mordey	85	33	.. ..	Conc. lead covd. and armd..	..	.	24	87 inc. ..	..	4½d.	Flat rate ..	..	..					
..	5 Parker	675	235	Chloride, 46 KW. for 5 hrs. ..	Callender, solid in iron trg.	£40,090	20,000	13,000	46 arc, 180 Nernst	235 H.P. ..	Ltg. 7d. & 2d., pr. 2d. to 1d.	Max. demand	212,654	3.1					
Mus- turbo.	6 Mather & Platt, 4 E. C. C., 1 Siemens, 2 Westinghouse, 2 Parsons	10,360																	
..	4 Westinghouse	7,200	12,115	Chloride, 480 KW.— hrs. ..	Bare copper, v. r., ppr., and v. bit., Callender, B.I.W., Siemens, Western Electric, Johnson & Phillips	£1,791,000	298,659	61,426	29 arc ..	1,025=3,298 H.P.	Ltg. 5½d. & 1½d., pr. 2d. to 1d., sliding scale	Max. demand & sliding scale from 5½d. to 1½d.	17,378,600	3.3					
Slip-	11 Electrical Co. (A. E. G.)	16,000*																	
dble.	2 Parker..	400	..	1,000 amp.-hrs.	Western Electric, triple conc. ppr. lead covd., laid solid in c'ware and iron tr.	£50,000	5,000 app. for	..	30 arc ..	12=20 H.P.	Ltg. 7d. & 2d., pr. 6d. & 1d.	Max. demand	..	..					
..	4 B. T. H.	1,000	..	Tudor, two, 560 amp.-hrs. ..	B.I.W., conc.	..	..	..	60 arc ..	..	6d. & 3d.	Max. demand	..	..					
..	2 Parker..	90	40	Pritchetts & Gold, 400 amp.-hrs.	Call. fdrs. armd. b. fibre, ld. shld., dest. 3-core l., sh. and armd., ld. direct	..	1,981	1,981	..	..	7d. & 4d.	Max. demand	..	..					
..	3 Parsons	360	118.4	D. P., 350 amp.-hrs.	Callender, lead covd. steel taped, conc. fdrs., 3-core dist.	£30,471	9,220	5,631	5 arc, 159 inc.	20=51½ H.P.	Ltg. 7d. & 4d., pr. 4d. & 1½d.	Max. demand	114,854	3.8					
..	3 Peebles, 1 Silvertown	630	450	Hart, ltg. 250 a.-h., chl. trac. 240 a.-h.	Callender, triple conc. fdr. in C. I. pipes, armd., dest. direct	..	3,500	..	25 inc. ..	2=41 H.P....	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand	380,214	..					
..	1 Crompton	21	..	Epstein	Bare copper overhead	£1,134	..	..	38 inc. ..	..	7½d.	Flat rate ..	..	..					
..	3 Mavor & Coulson	200	92	Stockton, 40 KW. for 5 hrs. ..	Callender, solid	£15,000	2,550	All	15 arc, 223 inc.	1=1 H.P. ..	Ltg. 5d., pr. 3d. ..	Flat rate with disc.	102,439	2.2					

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"Witton"

CONTINUOUS,

SINGLEPHASE,

& POLYPHASE

GENERATORS

DROP REDUCED

50

PER CENT.

BASTIAN

W. casing, Callender	£40,424	28,136	15,656	50 arc ..	49=500 H.P.	pr. 2½d. Ltg. 7d. & 1½d. or 5½d., pr. 2d., tr. 1½d.	Max. demand & flat rate	..	Pb. 3 2-5d. ..	..	..	Traction supply (250 KW.) to Greenock and Port Glasgow Tramway Co.	109						
nc., B.I.W. solid	£72,000	21,334	8,273	80 arc ..	16=45 H.P...	Ltg. 4½d., pr. 2½d. to 1½d.	Flat rate ..	653,438	2.51	.99	1.4	Energy supplied to Tramway Co. ..	110						
L., and 2-core solid; dist. Callender	£90,696	30,047	19,198	12 inc. ..	552 H.P. ..	Ltg. 7d. & 3d., pr. 4d. & 1½d. or 2½d.	Max. demand & flat rate	182,223	4.06	2.25	2.72	Data to Dec. 31st. 1902. Power load came on in Dec.	111						
, iron armd.	£26,855	8,000	2,000	..	..	Ltg. 6d., pr. 3d.	Flat rate ..	..	..	..	..	.. ..	112						

1899	W. M. Nelson ..	250 & 500	Direct ..	6 B. & W., stokers, econ., surf. cond.	3 comp., 3 triple, Belliss	7 Silvertown	1,100	600	Tudor, 100 KW. for 4 hrs. ..	Vulc. bit., solid and in C.W. casing, Callender
1901	W. A. Vignoles..	230	Direct ..	4 Lanc., 1 Stirling, econ., surf. cond. & clg. tr. ..	8 Belliss	8 Mather & Platt, 2 Westinghouse..	900	..	Tudor, 600 amp.-hrs.	Fdrs. conc., dist. triple conc., B.I.W. solid
1900	A. G. Bird ..	210 & 420	Direct ..	4 B. & W., econ.	4 Belliss	4 Parker	510	230	D. P., 35 KW. for 5 hrs.; Tudor, 100 KW. for 5 hrs.	Fdrs. triple conc., armd., and 2-core sol 3-core armd. and solid, Callender
1896	J. M. V. Money-Kent	215	Direct ..	3 B. & W., stokers, surf. cond.	5 Willans	3 Jackson, 2 Rosling	200	..	Chloride, 300 amp.-hrs. ..	Callender, v. bit. and fibre, iron armd. ..
1892	W. M. Rogerson	100, 230, & 460	25~, 3-ph. & direct	4 Lanc., 6 B. & W., stokers and econ.	3 Belliss vert. triple, 5 Pollit hor. comp., 2 Parsons turbines	8 E. C. C., 2 Parsons	3,200	2,143	Chloride, 150 KW. for 6 hrs.	V. r. Siemens, v. bit. and lead covd. ppr., Call
1894	C. A. Cowell ..	100 & 200	100~, 1-ph.	8 Lanc , econ.	6 Brush, 2 Ferranti	4 Mordey, 2 Ferranti A.C., 2 Brush arc	1,214	677	.. ..	H. p. v. r. and ppr., l.p. Callender single, and
1897	G. Wilkinson ..	100 & 200	50~, 1-ph.	5 Lanc., stokers, econ., suphtrs.	4 M'Laren (2 comp., 2 triple) vert., 1 Parsons turbine	3 Ferranti, 1 Siemens, 1 Parsons ..	1,150	660	.. ..	Conc , p r., lead covd., B.I.W. and Siemens
1896	E. R. Hill ..	220 & 440	Direct ..	4 B. & W., econ.	6 Willans	4 Crompton, 1 Mather & Platt, 1 Siemens	535	250	E. P. S.	Bare cpr., and Callender in ducts and solid
1883	Russell F. Ferguson	200	100~, 1-ph.	5 B. & W., econ., surf. cond. & clg. tr.	3 Brush, 2 Belliss, 1 Parsons turbine, 1 Peache	5 Brush, 1 Parsons, 1 Crompton ..	1,235	602	Tudor, 65 KW. hrs.	Paper, diatrine, Glover .. .. ..
1902	Arthur V. Rye ..	240 & 480	Direct ..	2 B. & W.	2 Belliss	2 Parker	180	88	D. P., 400 amp.-hrs.	Vulc. bit., laid solid in wood trough, Callende
1903	C. S. Vesey Brown	230 & 460	Direct ..	2 B. & W.	2 Allen	2 Crompton	400	..	232 Chloride, 500 amp.-hrs...	Callender, single, laid solid .. .. ..
1901	C. W. Fairweather G. H. Carter ..	230	Direct ..	2 Stewart, 1 B. & W., 1 Stirling, suphtrs., econ.	3 Reavell, 1 Howden, vert. comp. ..	2 Fowler, 1 Dick Kerr	380	115	Tudor, 350 amp.-hrs.; Chloride, 350 amp. hrs.	Ppr., solid, Henley .. ..
1899	F. G. Poulton ..	220 & 440	Direct ..	2 Lanc., econ., atmo. cond.	3 Belliss (2 comp., 1 triple)	3 Silvertown	450	147	Chloride, 660 amp.-hrs. ..	V. r. in bit., Silvertown .. .. ..
1900	Jas. Stott ..	200 & 400	Direct ..	2 Lanc., econ.	2 Reavell vert. comp.	2 Crompton	120	41	Marquand, 300 amp.-hrs. ..	V. bit. and ppr., lead covd., solid .. ..
1898	W. E. Brandreth	210 & 420	Direct ..	4 Paxman Economic, 1 Sugden feed htr., 1 B. & W. fired suphtr., cond.	4 Peache, 1 Belliss	5 Parker	820	380	Tudor, 120 KW. for 3 hrs. ..	Fdrs. conc., dist. 3-core, all armd. direct, Calle
1902	N. Stainland ..	240 & 480	Direct ..	3 dryback	2 Browett-Lindley	2 Mather & Platt	600	250	222 E. P. S., 1,200 amp.-hrs.	Siemens, triple conc., ppr., lead covd. armd. &
1892	C. B. Smith ..	220	Direct ..	2 Lanc., 5 E. & W., econ.	9 Willans, 1 Belliss	10 Crompton	1,208	751	Tudor, 127 KW.	Bare cpr. in ducts, insd. cable in iron pipes
1901	H. G. M'Haffie..	230	50~, 1-ph.	3 Lanc., econ. and suphtr.	4 Belliss	4 Crompton	375	154	Chloride, 24 KW. for 5 hrs...	Fibre, conc. solid, Callender .. ..
1903	A. B. Mountain	100 & 200	100~, 1-ph.	11 Lanc., 6 B. & W., stokers and econ.	3 Brush, 1 Universal; 2 McLaren, 2 Ferranti	4 Mordey, 2 Ferranti, 2 Siemen ..	3,290	1,415	.. ..	B.I.W. armd. conc. and Callender, solid..
1898	H. Bell (acting)	110 & 220	Direct ..	12 Lanc.	6 Willans, 5 Allen, 2 Browett-Lindley	2 Holmes, 11 Parker	4,030	2,735	Pritchetts & Gold, 600 amp.-hrs.	Bare cpr., Callender bit. and Siemens arm Siemens conc. fdr. in ducts.
1901	A. H. Shaw ..	230 & 460	Direct ..	4 B. & W., 2 dryback, suphtrs. and econ... ..	5 Willans	3 G. E. Co., 2 Dick Kerr	1,600	805	E. P. S., 600 amp.-hrs. ..	Conc. armd. fdrs., solid dist., Henley ...
1903	C. O. Pilsher ..	230 & 460	Direct ..	Bulk supply from Derby and Notts. Electric Power Co.			..	..	.. ..	Callender, laid solid .. ..
1900	J. Gould.. ..	100 & 200	Direct ..	.. ..	2 Turbines	2 J. P. Hall	20	16	D. P., 27 H.	Callender, 2 and 3 core lead covd. and armd.
1903	.. .. ..	230	Direct ..	4 dryback	4 Reavell (2 ltg., 2 ltg. & tr.) ..	4 A. E. G.	690	..	400 amp.-hrs.	Ppr., lead covd., solid in wood, Johnson & Phi
1902	W. E. Tooth ..	230 & 460	.. ..	2 B. & W. marine, 1 Fraser dryback	4 Universal	4 Brush..	300	66	420 amp.-hrs., 280 amp. max.	Fdrs. triple conc., dist. 3-core, solid ..
1901	J. M. Smyth ..	230 & 460	Direct ..	2 Lanc., stokers, econ., ejector cond.	3 Allen, vert. comp.	3 Parker..	440	140	Tudor, 35 KW. for 10 hrs. ..	Jute, lead covd., & vulc. bit., single, Callender
1902	T. N. Ritson ..	220 & 440	Direct ..	Fraser's Economic	2 Willans	2 Johnson & Phillips..	72	..	Tudor, 20 KW. for 5 hrs. ..	Triple conc., B.I.W. .. ..
1890	.. .. ..	100	75~, 1-ph.	1 Lanc.	1 Westinghouse, 1 Victor turbine ..	2 Kapp	60	..	.. ..	V. r. underground and overhead .. ..
1900	W. Griffiths ..	230 & 460	Direct ..	5 B. & W., Wilson smokeless process and econ.	3 Brush, 2 Parsons turbine	3 Mordey, 2 Parsons	1,050	..	Chloride, & Pollak, 750 amp.-hrs.	Armd., lead covd., conc.; sep. power cables, 3- covd., solid, B.I.W.
1893	L. C. Trevor-Roper	100	100~, 1-ph.	1 loco-type, jet cond.	1 Fowler hor. comp 1 turbine, 1 water-wheel	2 Mordey, 1 Ferranti	169	79	.. ..	Callender and St. Helens armd. conc. fdrs., lead covd. conc. dist.
1899	J. Pilling ..	200 & 400	Direct ..	2 Lanc., econ., jet cond., 2 vert. for producer plant.	2 Belliss (steam), 5 Fielding & Platt (gas)	2 Laurence Scott, 5 G. E. Co. ..	520	250	Chloride, 30 KW. for 5 hrs. ..	Fdrs. jute, conc. lead covd. in ducts. & armd dist., triple conc. armd. direct, ppr. B.I.W.
1903	O. F. Francis ..	230 & 460	Direct ..	3 Stirling	5 Browett-Lindley	5 Laurence Scott	690	300	80 amps. 5 hrs., 120 amps. 3 hrs.	Henley single lead covd. solid in wood ..
1893	J. E. Edgcome..	105	77~, 1-ph.	3 Lanc., 4 B. & W., stokers, suphtrs., surf. cond., econ.	10 Belliss	10 Siemens	630	332	.. ..	Armd. conc. Siemens laid direct .. ..
1894	W. A. Tester ..	100 & 200	Direct ..	5 Lanc., 2 Lancs., & desteter.	4 Willans, 1 Westinghouse, 4 Belliss	3 Brush, 1 Mather & Platt, 5 Westinghouse	1,200	660	.. ..	Callender .. ..
1892	M. G. Smyth ..	100 & 200	100~, 1-ph.	2 Cornish induced draught	2 Combe Barbour hor. cond. ..	2 Mordey	80	60	.. ..	B.I.W. armd. direct and solid, and bare copper
1887	F. W. E. Jones	115 & 230	Direct ..	3 Robey loco., cond.	3 Robey comp...	5 Chamberlain & Hookham	350	151	E. P. S. 1,000 a.-h., Hart 1,500 a.-h.	Jute, lead covd., fdrs. armd., dist. solid, Callen
1898	H. Dickinson ..	100 & 200	83~, 1-ph., 50~, 2-ph.	14 Lanc., 10 B. & W., stokers, econ., suphtrs. and cond.	1 Fowler, 2 Hick-Hargreaves, 12 Belliss, 1 McLaren	4 Ferranti, 9 E. C. C., 3 Fowler ..	8,740	4,126	.. ..	B.I.W., Henley and Silvertown .. ..
1894	A. Colson ..	100 & 200	50~, 1-ph.	6 B. & W., 5 Lanc.	6 Hick Hargreaves, horiz.	4 Ganz, 2 Brush	3,400	1,789	.. ..	Paper conc. .. ..
1899	B. M. Kinghorn	220 & 440	Direct ..	2 Lanc., & 1 water tube	2 Willans, 1 Galloway	4 Mather & Platt	250	264	Chloride, 150 KW. for 1 hr. ..	Triple conc., B.I.W., Johnson & Phillips, and Cable Co.
1899	A. P. Rutherford	230 & 460	Direct ..	4 Lanc., econ.	7 Belliss	7 Silvertown	1,000	546	E. P. S. 750 amp.-hrs. ..	Triple conc., ppr., direct with steel plates, and wood
1901	W. F. Bolton ..	230 & 460	Direct ..	3 B. & W., suphtrs, jet. cond., feed htr.	2 Universal vert. comp., 1 Allen ..	3 Mordey	210	78.5	Hart, 10 KW. for 6 hrs. ..	Western Electric solid .. .. ..
1896	F. H. Lewis ..	150 & 300	Direct ..	8 Paxman, econ.	6 Willans	5 Mather & Platt, 1 A. E. G. ..	1,572	779	125 KW. for 4 hrs.	Armd. conc., also lead covd. in ducts for dist.
1897	E. J. S. Ritter ..	110 & 220	100~, 1-ph.	.. ..	Turbines	4 Siemens	240	95	.. ..	Bare copper .. ..
1902	.. .. ..	230 & 460	Direct ..	.. ..	3 Westinghouse gas engines.. ..	3 A. E. G.	..	..	.. ..	Fdrs. conc., dist. single, laid solid.. ..
1898	S. Clegg	230	Direct ..	5 Marine, econ., water softener	6 Willans	7 Laurence Scott	738	331	Chloride, 300 amp.-hrs. ..	V. bit. armd., conc. and triple conc., Callender
1883	A. Clough (Res.)	230 & 460	Direct ..	73 Lanc., stokers, 6 econ.	63 Willans	66 Siemens & E. C. C.	21,190	10,539	K. L. P. type, E. P. S. ..	Callender solid.. .. ..
1897	W. M. Horsfall..	220	Direct ..	3 Lanc., stokers, feed htr.	3 Willans, 2 Browett-Lindley ..	3 Parker, 1 Siemens, 1 Robinson ..	348	234	E. P. S., 35 KW. for 4 hrs. ..	Callender solid.. .. ..
1902	.. .. ..	230 (2-wire)	Direct ..	1 Cornish	1 Browett-Lindley	1 Bertram Thomas	50	..	.. ..	Glover, lead covd. and armd. direct ..
1897	A. H. Sears ..	230 & 460	Direct ..	3 Lanc.	1 Willans, 1 Alley & MacLellan, 1 Reavell	1 Siemens, 1 Mather & Platt, 1 Bertram Thomas	240	..	.. ..	Glover conc. and single, B.I.W. & Helsby 2-co direct
1893	H. Morton ..	220 & 440	Direct ..	6 B. & W. (2 combined Beaman & Deas destructor) econ.	3 Belliss, 3 Allen, vert. comp. ..	4 Silvertown, 2 Crompton	700	412	Pritchetts & Gold, 500 amp.-hrs.	Triple conc. fdrs., armd., lead cov., 3-core dist.
1894	R. V. Macrory ..	2,150 to 2,500	Direct ..	2 Lanc., econ., cond.	3 Brown & Sons, vert. comp. ..	6 Siemens arc...	150	93.5	.. ..	V. r. single core armoured .. ..
1901	W. Langford ..	230 & 460	Direct ..	2 B. & W., econ.	2 Belliss..	2 E. C. C.	300	64	Chloride 40 KW. for 13 hrs...	Vulc. bitumen, solid .. ..
1901	G. A. Bruce ..	230 & 460	Direct ..	4 B. & W., suphtrs., surf. cond.	2 Musgrave, 2 Browett-Lindley ..	3 B. T. H., 1 Lanc. Dynamo Co. ..	975	275	Chloride..	V. r. conc. fdrs. and dist., Callender, solid
1901	W. H. Cooke ..	250 & 500	Direct ..	2 Lanc., sf. cond., econ., suphtr., water softener	4 Allen vert. comp.	5 Allen	297	128	Chloride, 280 cells, 400 amp.-hrs.	Callender, v. bit. 3-core dist., conc. fdrs. & si diable v. b.
1900	Glynn Salter ..	240 & 480	Direct ..	2 B. & W., suphtrs.	2 Belliss..	2 Parker	124	107*	D. P., 20 KW. for 8 hrs. ..	Callender, triple conc. fdrs., 3-core dist., all arm
1889	P. T. Kimmins	100	100~, 1-ph.	1 loco.	1 Sherman (steam), 1 Escher Wyss, 5 Pelton (water)	2 Mordey, 1 E. C. C.	150	54	.. ..	Diatrine twin and conc., Glover and St. Helens
1898	L. O'Connor ..	2,000	100~, 1-ph.	"	1 portable, Clayton & Shuttleworth,* 1 turbine	1 Mordey	35	33	.. ..	Conc. lead covd. and armd. .. .. ..
1901	E. E. Hoadley ..	230 & 460	Direct ..	4 Paxman dryback	5 Peache	5 Parker	675	235	Chloride, 46 KW. for 5 hrs. ..	Callender, solid in iron trg. .. .. ..
1893	G. F. Metzger ..	100, 200, & 400	Direct .. *Dickinson Street*:—18 Lanc., 4 B. & W., stokers, jet. cond., econ. Direct .. *Bloom Street*:—11 B. & W., stokers, surf. cond., econ. 50~, 3-ph. 6,500 volts *Stuart Street*:— B. & W., stokers, jet and surf. cond., clg. trs., econ.		4 Galloway, 5 Goodfellow, 2 Musgrave, 2 Ferranti, 2 Parsons turbo. 4 Musgrave .. .. 6 Yates & Thom, 2 Wallsend Slipway, 3 Willans	6 Mather & Platt, 4 E. C. C., 1 Siemens, 2 Westinghouse, 2 Parsons 4 Westinghouse .. .. .. 11 Electrical Co. (A. E. G.)	10,350 7,200 16,000*	12,115	Chloride, 480 KW.— hrs. ..	Bare copper, v. r., ppr., and v. bit., Callender, Glover, Western Electric, Johnson & Phillip
1903	E. Holcombe Hewlett	240	Direct ..	3 Lanc., 2 water-tube, econ., Proctor stokers, Ledward ejector cond., forced draught	Alley & McLellan, triple exp. dble. acting	2 Parker..	400	..	1,000 amp.-hrs.	Western Electric, triple conc. ppr. lead covd., in e'ware and iron tr.
1901	R. Humphries ..	240 & 480	Direct ..	4 B. & W., econ.	2 Allis hor., 2 Belliss vert.	4 B. T. H.	1,000	..	Tudor, two, 500 amp.-hrs. ..	B.I.W., conc. .. ..
1903	C. W. Bentley ..	240	.. ..	1 Davey Paxman loco., Boby heater	2 Belliss..	2 Parker..	90	40	Pritchetts & Gold, 400 amp.-hrs.	Call. fdrs. armd. b. fibre, ld. shld., dest. 3-co and armd., ld. direct .. .. ..
1900	W. H. Russell ..	240 & 480	Direct ..	3 B. & W., suphtrs., stokers, econ., ejector cond.	3 Parsons turbines	3 Parsons	800	118.4	D. P., 350 amp.-hrs.	Callender, lead covd. steel taped, conc. fdrs dist.
1901	A. L. Plunket ..	230 & 460	Direct ..	4 B. & W., surf. cond.	4 Browett-Lindley vert. comp. ..	3 Peebles, 1 Silvertown	630	350	Hart, ltg. 250 a.-h., chl. trac. 240 a.-h.	Callender, triple conc. fdr. in C. I. pipes, arm direct
1895	J. G. Hill ..	110	Direct ..	1 Paxman	Paxman under-type engine	1 Crompton	23	..	Epstein	Bare copper overhead .. .. ..
1902	H. Waring ..	220	Direct ..	2 Lanc., feed heaters	2 Alley & Maclellan, 1 Belliss ..	3 Mavor & Coulson	200	92	Stockton, 40 KW. for 5 hrs. ..	Callender, solid .. ..

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SULPHURIC ACID
SPECIALLY PREPARED
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ACCUMULATORS

ELECTRIC LAMP MAKERS
By Special Appointment to
HIS MAJESTY THE KING.
ROYAL EDISWAN LAMPS
Made in England.

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CONTINU
SING

128	HULL	Corporation	1893	H. Bell (acting)	110 & 220	Direct ..	12 Lanc.	6 Willans, 5 Allen, 2 Browett-Lindley	2 Holmes, 11 Parker	
129	ILFORD	Urban District Council	1901	A. H. Shaw ..	230 & 460	Direct ..	4 B. & W., 2 dryback, suphtrs. and econ... ..	5 Willans	3 G. E. Co., 2 Dick	

LATORS

Made in England.

ABSOLUTELY

& POLYPHASE

GENERATORS

BASTIAN

n C.W. casing, Callender	£40,424	28,136	15,656	50 arc ..	49=500 H.P.	pr. 2½d. Ltg. 7d. & 1½d. or 5½d., pr. 3d., tr. 1½d.	Max. demand & flat rate	..	Pb. 3 2-5d. ..	..	..	Traction supply (250 KW.) to Greenock and Port Glasgow Tramway Co.	109
le conc., B.I.W. solid	£72,000	21,334	8,273	80 arc ..	16=45 H.P...	Ltg. 4½d., pr. 2½d. to 1½d.	Flat rate ..	653,438	2.51	.99	1.4	Energy supplied to Tramway Co. ..	110
armd., and 2-core solid; dist. lid, Callender	£90,696	30,047	19,198	12 inc. ..	552 H.P. ..	Ltg. 7d. & 3d., pr. 4d. & 1½d. or 2½d.	Max. demand & flat rate	182,223	4.06	2.25	2.72	Data to Dec. 31st. 1902. Power load came on in Dec.	111
fibre, iron armd.	£26,855	8,000	2,000	.. ..	..	Ltg. 6d., pr. 3d.	Flat rate ..	..	..	..	..	.. ..	112
and lead covd. ppr., Callender ..	£212,579	80,172	10,272	69 arc, 100 inc	77=294 H.P.	Ltg. 4d., pr. 2d. ..	Flat rate ..	3,187,369	2.19	·92	1.21	Lighting and traction	113
p. Callender single, and B.I.W...	£73,330	44,973	4,549	68 arc, 191 inc	36=30 H.P.	Ltg. 6d. & 3d., pr. 3d. & 1d.	Max. demand	..	..	..	..	.. ..	114
, B.I.W. and Siemens	£92,200	45,190	7,995	60 arc, 170 inc.	36=130 H.P.	Ltg. 6d., 4d., 3d. or 6d. & 3d., pr. 2d.	Max. demand	761,136	4.75	1.30	1.91	Price 6d. and 2d. over 15,000 units ..	115
ler in ducts and solid	£56,892	18,000	..	..	14=55 H.P.	Ltg. 8d. & 4d., pr. 4d.	Max. demand & flat rate	..	..	..	..	.. ..	116
r	£128,944	33,443	4,015	104 arc ..	7=8 H.P...	6d., or 10s. per an. per lp. & 1½d. per u.	Flat rate & Hopkinson	803,761	Priv. 5 Pub. 3.55	1.97	2.49	.. ..	117
a wood trough, Callender.. ..	..	7,319	..	10 arc, 105 inc.	10=37 H.P.	Ltg. 7d. & 3d., pr. 4d. & 1½d.	Max. demand	38,695	4.1	1.47	2.04	200 KW. extns. in hand; sup. com. June 1st, 1902; data to Dec. 31st.	118
solid	..	..	..	10 arc, 150 inc	..	Ltg. 4½d., pr. 2d. to 1½d.	Flat rate & sliding scale	..	..	..	..	.. ..	119
. .. .	£20,000	7,285	1,932	10 arc, 224 inc.	10=36 H.P...	Ltg. 6d. & 3d. or 5d., pr. 2d. or 1d.	Max. demand & flat rate	73,631	Pri. 4.39 Pub 2.	.89	2.08	Lighting and traction	120
rn	£25,239	9,372	1,115	..	13=42 H.P...	Ltg. 6d. & 4d., pr. 3d. & 2d.	Max. demand	108,815	4.85	..	2.2	Auxiliaries driven by electric motors ..	121
covd., solid	£15,000	3,330	..	4 arc.. ..	13=64 H.P. .	Ltg. 6d. & 3d., pr. 2½d. & 1½d.	Accdg. to lps. installed .	39,679	4.23	..	4.31	.. ..	122
e, all armd. direct, Callender ..	£60,000	28,037	6,020	10 arc, 238 inc.	..	Ltg. 5d. & 2d., pr. 4d. & 1d.	Max. demand	405,750	3.47	1.47	1.98	Traction under consideration	123
ppr., lead covd. armd. & laid solid	£73,335	12,000	..	50 arc. ..	2=3 H.P. ..	Ltg. 7d. & 2d., pr. 2½d.	Max. demand & flat rate	..	..	..	..	.. ..	124
d. cable in iron pipes	£127,103	69,882	8,434	..	50=141 K.W.	Ltg. 7d. & 4d., pr. 3d.	Max. demand	735,816	5.48	1.85	2.45	KW. for motors includes heating ..	125
lender	£43,000	18,000	6,000	252 lamps= 574 8 c. p.	4=2 H.P. ..	Ltg. 7d. & 8d. or 5½d. pr. 3d. & 1½d.	Max. demand & flat rate	155,273	4.4	3	..	25 KW. motor alternator for charging batteries and taking day load.	126
nd Callender, solid..	£164,596	113,921	13,187	38 arc, 48 inc.	103=436 H.P.	Ltg. 4½d., pr. 2½d. & 1d.	Flat rate ..	1,298,255	3.94	.99	1.43	.. ..	127
bit. and Siemens armd. dist., n ducts.	£252,546	192,453	62,123	12 arc ..	234=1959 H.P.	Ltg. 5d. & 2d. or 4½d., pr 2d. to 1d.	Max. demand fl. r. & s. c.	2,385,577	3.13	1.28	1.66	.. ..	128
d dist., Henley	£76,000	36,230	19,311	44 arc, 807 inc	28=137 H.P.	8d. & 3d. or 5d. ..	Max. demand or flat rate	772,188	..	..	1.18	Lighting and traction	129
. .. .	..	..	..	..	..	Ltg. 4½d., pr. 3d...	Flat rate ..	..	..	..	..	.. ..	130
e lead covd. and armd. direct	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Flat rate	33,200	..	..	..	Water plentiful except during prolonged frost.	131
in wood, Johnson & Phillips ..	..	..	..	..	..	Ltg. 6d. to 4½d., pr. 2d. to 1½d.	Flat rate with discount ..	..	..	..	..	.. ..	132
. 3-core, solid	..	3,069	387	..	8=17 H.P. ..	Ltg. 7d. & 1d., pr. 4d. & 1½d.	Max. demand	..	..	..	..	.. ..	133
c. bit., single, Callender solid ..	£38,000	8,000	2,300	24 arc, 48 inc.	30=124 H.P.	Ltg. 7d. & 3d. or 5d., pr. 2½d. to 1½d.	Max. demand & flat rate	139,000	3.45	1.28	2.66	.. ..	134
. .. .	..		Not yet completed			6d. & 3d.	Flat rate ..	..	..	..	..	.. ..	135
d overhead	..	..	..	..	..	6d.	Flat rate ..	..	..	..	..	Management in the hands of the Windermere Co.	136
c.; sep. power cables, 3-core lead	..	..	..	..	..	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand with disc.	343,594	..	1.44	..	Lighting and traction	137
elens armd. conc. fdrs., Callender ..	..	3,200	..	3 inc. ..	..	5d.	Contract & flat rate	..	..	..	..	.. ..	138
covd. in ducts. & armd. direct; md. direct, ppr. B.I.W. solid	£45,081	15,212	3,202	22 arc, 470 inc.	25=109 H.P.	Ltg. 5d. & 4½d., pr. 3d. & 1½d.	Flat rate ..	323,175	3.27	1.08	1.45	Steam and gas station	139
d. solid in wood	£50,000	4,050	4,050	100 arc ..	11=25 H.P.	Ltg. 5½d., pr. 2½d.	Flat rate with disc.	..	..	..	..	Lighting and traction	140
laid direct	£82,784	25,767	2,882	76 arc ..	7=20 H.P...	Ltg. 6d. & 3d., pr. 3d. & 2d.	Max. demand & flat rate	392,962	5.094	2.45	5.66	.. ..	141
. .. .	£55,195	31,640	3,625	34 arc, 68 inc.	46=100 H.P.	Ltg. 5d., pr. 3d. ..	Flat rate ..	393,960	4.80	1.87	2.41	Erecting new works for lighting and traction	142
nd solid, and bare copper.. ..	..	2,200	..	14 arc, 125 inc	.	2d. to 8d.	Contract & meters	..	..	..	..	.. ..	143
armd., dist. solid, Callender ..	..	13,810	3,692	..	11=19½ H.P.	Ltg. 7d. & 3½d. or 6d., pr. 4d.	M. d., Hop. & flat rate*	..	..	..	..	* Also 2-rate meters used	144
ilvertown	£338,098	194,114	53,312	93 arc ..	382=1,437 H.P	Ltg. 4d., pr. 1½d. to 2d.	Ltg. flat rate, pr. max. dem.	4,448,650	3.02	.62	.85	No meter rents. * Also 50~, 1-ph. ..	145
. .. .	£216,232	130,163	28,302	..	72=192 H.P.	Ltg. 4d., pr. 2d. ..	Flat rate ..	1,425,713	3.87	0.98	1.45	.. ..	146
Johnson & Phillips, and Anchor	£22,000	11,875	2,472	.. ..	75=532½ H.P	Ltg. 7d. & 2½d. or 5d., pr. 3d. & ¼d.	Max. demand & flat rate	344,898	2.5	1.06	1.31	.. ..	147
ct with steel plates, and solid in	£70,000	35,117	8,685	223 arc ..	73=416 H.P.	Ltg. 4d., pr. 1¾d..	Flat rate with disc.	..	..	..	..	.. ..	148
. .. .	£22,677	4,638	1,638	..	5=18½ H.P.	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand	42,842	5.12	2.74	5.21	.. ..	149
covd. in ducts for dist.	£125,000	40,248	7,444	72 arc, 529 inc.	20=43½ H.P.	Ltg. 5d. & 2d., pr. 5d. & 1d.	Max. demand	1,005,057	3.31	1.073	1.522	.. ..	150
. .. .	..	1,000	50	..	..	10s. per 8 c.p. ..	Contract ..	..	..	..	..	.. ..	151
e, laid solid..	..	..	..	..	..	Ltg. 5d., pr. 2d. ..	Flat rate ..	..	..	..	..	.. ..	152
d triple conc., Callender	£35,550	20,960	3,931	30 arc, 107 inc.	39=79 H.P...	Ltg. 6d. & 2½d., pr. 4d. & 1d., or 2½d.	Max. demand & disc.	339,626	..	..	..	.. ..	153
. .. .	£1,386,709	441,848	79,868	174 arc, 56 inc.	827=2,877 H.P.	Ltg. 3½d. & 3d., pr. 2d. & 1½d., tr. 1.2d.	Sliding scale	23,186,083	1.89	.71	.92	Lighting and traction. Data to Dec. 31st, 1902	154
. .. .	£46,000	21,032	3,752	18 inc., 4 Nernst.	3=5 H.P. ..	Ltg. 5d., pr. 3d. ..	Flat rate ..	162,468	5.20	1.86	3.13	* Gt. Crosby and Waterloo	155
armd. direct	..	..	..	..	..	Ltg. 6d., pr. 4d. ..	Flat rate ..	..	..	..	..	.. ..	156
le, B.I.W. & Helsby 2-core, armd.	..	..	..	..	..	Ltg. 6d., pr. 6d. to 3½d.	Flat rate and scale	..	..	..	..	.. ..	157
d., lead covd., 3-core dist. direct..	£35,199	16,000	..	48 arc ..	12=75 H.P.	Ltg. 7d. & 2d. or 5d., pr. 2d.	Max. demand & flat rate	309,200	4.07	1.6	..	Max. load in summer	158
ured	£19,786	..	..	183 arc ..	..	..	..	..	..	..	..	Only public are lighting undertaken except 19 private lamps	159
. .. .	£20,992	4,336	2,803	..	14=21½ H.P.	Ltg. 8d. & 2d., pr. 2½d.	Max. demand	58,846 (inc. works)	5	1.91	..	.. ..	160
ist., Callender, solid	£58,000	18,274	5,779	70 arc, 232 inc.	13=46 H.P.	Ltg. 7d. & 3d., pr. 2½d.	Max. demand	276,482	5	1.75	2.20	.. ..	161
ore dist., conc. fdrs. & sing. core	£28,103	6,737	2,717	10 arc, 27 inc.	11=38 H.P.	Ltg. 6d. & 3d., or 4½d., pr. 2d. & 1½d.	Max. demand & flat rate	92,690	4.06	1.57	2.71	.. ..	162
fdrs., 3-core dist., all armd. ..	£23,000	5,747	2,244	2 arc, 109 inc.	4=6½ H.P...	Ltg. 7d. & 4d., pr. 4d. & 1½d.	Max. demand	65,594	4.65	2.2	3.	* Coronation; 64 normal	163
c., Glover and St. Helens.. ..	£7,500	2,250	400	1 arc, 84 inc.	..	5d.	Flat rate ..	80,491	..	..	..	.. ..	164
rmd...	..	.	24	87 inc. ..	..	4½d.	Flat rate ..	..	..	..	..	* In course of renewal	165
n trg...	£40,000	20,000	13,000	46 arc, 180 Nernst	235 H.P. ..	Ltg. 7d. & 2d., pr. 2d. to 1d.	Max. demand	212,634	3.26	1.636	2.496	Supply to tramways later	166
r., and v. bit., Callender, B.I.W., ctric, Johnson & Phillips	£1,791,000	598,659	61,426	29 arc ..	1,025=3,298 H.P.	Ltg. 5½d. & 1¾d., pr. 2d. to 1d., sliding scale	Max. demand & sliding scale from 5½d. to 1¾d.	17,378,600	3.48	1.08	1.55	Corporation tramways supplied from Dickinson St., Bloom St., and Stuart St. Works. Plant installed for 800 cars. * 7,500 KW. under constructn.	167
le conc. ppr. lead covd., laid solid r.	£50,000	5,000 app. for	..	30 arc ..	12=20 H.P.	Ltg. 7d. & 2d., pr. 6d. & 1d.	Max. demand	..	..	..	..	Lighting and traction, destructor attached	168
. .. .	..	..	..	60 arc ..	..	6d. & 3d.	Max. demand	..	..	..	..	Lighting and traction	169
fibre, ld. shld., dest. 3-core l., sh. t	..	1,981	1,981	.. ..	..	7d. & 4d.	Max. demand	..	..	..	..	.. ..	170
steel taped, conc. fdrs., 3-core	£30,471	9,220	5,631	5 arc, 159 inc.	20=51½ H.P.	Ltg. 7d. & 4d., pr. 4d. & 1½d.	Max. demand	114,854	3.71	1.45	2.56	.. ..	171
. fdr. in C. I. pipes, armd., dest.	..	3,500	..	25 inc. ..	2=41 H.P....	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand	380,214	..	..	..	Lighting and traction. Highfield booster	172
.. ..	£1,134	..	..	38 inc. ..	..	7½d.	Flat rate ..	..	..	..	..	.. ..	173
. .. .	£15,000	2,550	All	15 arc, 226 inc.	1=1 H.P. ..	Ltg. 5d., pr. 3d. ..	Flat rate with disc.	102,439	2.85*	1.35	2.22	Worked in conjunctn. with destructor. * Includes maintnce. of public lamps	174

"Witton"

CONTINUOUS,

SINGLEPHASE,

& POLYPHASE

DROP REDUCED

50

PER CENT.

BASTIAN

Western Electric Co.

CABLES,

RUBBER WIRES,

ndley	2 Homes, 11 Parker	4,000	2,736	Pritchetts & Gold, 600 amp.-hrs.	Bare cpr., Callender bit. and Siemens armd. dist., Siemens conc. fdr. in ducts.	£252,546	192,453	62,123	12 arc ..	234=1959 H.P.	Ltg. 5d. & 2d. or 4½d., pr 2d. to 1d.	Max. demand fl. r. & s. c.		
..	3 G. E. Co., 2 Dick Kerr	1,600	805	E. P. S., 600 amp.-hrs. ..	Conc. armd. fdrs., solid dist., Henley	£76,000	36,230	19,311	44 arc, 807 inc	28=137 H.P.	8d. & 3d. or 5d. ..	Max. demand		

128	HULL	Corporation	[illegible]	[illegible]	[illegible]	Direct	12 Lanc.	6 Willans, 5 Allen, 2 Browett-Lindley	2 Holmes, 11 F
129	ILFORD	Urban District Council	1901	A. H. Shaw	230 & 460	Direct	4 B. & W., 2 dryback, suphtrs. and econ.	5 Willans	3 G. E. Co., 2 I
130	ILKESTON	Corporation	1938	C. O. Pilcher	230 & 460	Direct	Bulk supply from Derby and Notts. Electric Power Co.		
131	INCLETON	I. Elec. Lighting & Power Co.	1900	J. Gould	100 & 200	Direct	2 Turbines	2 J. P. Hall
132	IPSWICH	Corporation	1903		230	Direct	4 dryback	4 Reavell (2 ltg., 2 ltg. & tr.)	4 A. E. G.
133	JARROW	County of Durham El. Pr. Dist. Co.	1902	W. E. Tooth	230 & 460		2 B. & W. marine, 1 Fraser dryback	4 Universal	4 Brush
134	KEIGHLEY	Corporation	1901	J. M. Smyth	230 & 460	Direct	2 Lanc., stokers, econ., ejector cond.	3 Allen, vert. comp.	3 Parker
135	KENDAL	Corporation	1902	T. N. Ritson	220 & 440	Direct	Fraser's Economic	2 Willans	2 Johnson & F
136	KESWICK	K. Electric Light Co., Ltd.	1890		100	75~, 1-ph.	1 Lanc.	1 Westinghouse, 1 Victor turbine	2 Kapp
137	KIDDERMINSTER	K. and Dist. Elec. Ltg. and Tr. Co.	1900	W. Griffiths	230 & 460	Direct	5 B. & W., Wilson smokeless process and econ.	3 Brush, 2 Parsons turbine	3 Mordey, 2 Pa
138	KILLARNEY	Killarney Electric Lighting Co.	1893	L. C. Trevor-Roper	100	100~, 1-ph.	1 loco-type, jet cond.	1 Fowler hor. comp 1 turbine, 1 water-wheel	2 Mordey, 1 Fe
139	KING'S LYNN	Corporation	1899	J. Pilling	200 & 400	Direct	2 Lanc., econ., jet cond., 2 vert. for producer plant.	2 Belliss (steam), 5 Fielding & Platt (gas)	2 Laurence Sco
140	KIRKCALDY	Corporation	1903	O. F. Francis	230 & 460	Direct	3 Stirling	5 Browett-Lindley	5 Laurence Sco
141	KINGSTON-UPON-THAMES	Corporation	1893	J. E. Edgcome	105	77~, 1-ph.	3 Lanc., 4 B. & W., stokers, suphtrs., surf. cond., econ.	10 Belliss	10 Siemens
142	LANCASTER	Corporation	1894	W. A. Tester	100 & 200	Direct	5 Lanc., 2 Lancs., & destctor.	4 Willans, 1 Westinghouse, 4 Belliss	3 Brush, 1 Mat inghouse
143	LARNE	L. Electric Lighting Works	1892	M. G. Smyth	100 & 200	100~, 1-ph.	2 Cornish induced draught	2 Combe Barbour hor. cond.	2 Mordey
144	LEAMINGTON	Midland Elec. Lt. & Pr. Co.	1887	F. W. E. Jones	115 & 230	Direct	3 Robey loco., cond.	3 Robey comp.	5 Chamberlain
145	LEEDS	Corporation	1893	H. Dickinson	100 & 200	83~, 1-ph., 50~, 2-ph.	14 Lanc., 10 B. & W., stokers, econ., suphtrs. and cond.	1 Fowler, 2 Hick-Hargreaves, 12 Belliss, 1 McLaren	4 Ferranti, 9 E
146	LEICESTER	Corporation	1894	A. Colson	100 & 200	50~, 1-ph.	6 B. & W., 5 Lanc.	6 Hick Hargreaves, horiz.	4 Ganz, 2 Brus
147	LEICH	Corporation	1899	B. M. Kinghorn	220 & 440	Direct	2 Lanc., & 1 water tube	2 Willans, 1 Galloway	4 Mather & Pla
148	LEITH	Corporation	1899	A. P. Rutherford	230 & 460	Direct	4 Lanc., econ.	7 Belliss	7 Silvertown
149	LEWES	Lew s & Dis. Elec. Supply Co.	1901	W. F. Bolton	230 & 460	Direct	3 B. & W., suphtrs, jet. cond., feed htr.	2 Universal vert. comp., 1 Allen	3 Mordey
150	LEYTON	Urban District Council	1896	F. H. Lewis	150 & 300	Direct	8 Paxman, econ.	6 Willans	5 Mather & Pla
151	LIMAVADY	L. Power and Light Works	1897	E. J. S. Ritter	110 & 220	100~, 1-ph.		Turbines	4 Siemens
152	LIMERICK	Corporation	1902		230 & 460	Direct		3 Westinghouse gas engines	3 A. E. G.
153	LINCOLN	Corporation	1898	S. Clegg	230	Direct	5 Marine, econ., water softener	6 Willans	7 Laurence Sco
154	LIVERPOOL	Corporation	1883	A. Clough (Res.)	230 & 460	Direct	73 Lanc., stokers, 6 econ.	63 Willans	66 Siemens & E
155	LIVERPOOL DISTRICT*	Liverpool District Lighting Co.	1887	W. M. Horsfall	220	Direct	3 Lanc., stokers, feed htr.	3 Willans, 2 Browett-Lindley	3 Parker, 1 Sie
156	LLANDILO	Urban District Council	1902		230 (2-wire)	Direct	1 Cornish	1 Browett-Lindley	1 Bertram Tho
157	LLANDRINDOD WELLS	L. W. Electric Light & Power Co.	1897	A. H. Sears	230 & 460	Direct	3 Lanc.	1 Willans, 1 Alley & MacLellan, 1 Reavell	1 Siemens, 1 Bertram Tho
158	LLANDUDNO	Urban District Council	1898	H. Morton	220 & 440	Direct	6 B. & W. (2 combined Beaman & Deas destructor) econ.	3 Belliss, 3 Allen, vert. comp.	4 Silvertown, 2
159	LONDONDERRY	Corporation	1894	R. V. Macrory	3,150 to 2,500	Direct	2 Lanc., econ., cond.	3 Brown & Sons, vert. comp.	6 Siemens arc.
160	LONGTON	Corporation	1901	W. Langford	230 & 460	Direct	2 B. & W., econ.	2 Belliss	2 E. C. C.
161	LOWESTOFT	Corporation	1901	G. A. Bruce	230 & 460	Direct	4 B. & W., suphtrs., surf. cond.	2 Musgrave, 2 Browett-Lindley	3 B. T. H., 1 L
162	LUTON	Corporation	1901	W. H. Cooke	250 & 500	Direct	2 Lanc., sf. cond., econ., suphtr., water softener	4 Allen vert. comp.	5 Allen
163	LYMINGTON	L. Electric Light & Power Co.	1900	Glynn Salter	240 & 480	Direct	2 B. & W., suphtrs.	2 Belliss	2 Parker
164	LYNTON & LYNMOUTH	Lynton & Lynmouth E. L. Co.	1889	P. T. Kimmins	100	100~, 1-ph.	1 loco.	1 Sherman (steam), 1 Escher Wyss, 5 Pelton (water)	2 Mordey, 1 E.
165	MACROOM	M. & Dist. Elec. Ltg. Syndicate	1898	L. O'Connor	2,000	100~, 1-ph.		1 portable, Clayton & Shuttleworth, 1 turbine	1 Mordey
166	MAIDSTONE	Corporation	1901	E. E. Hoadley	230 & 460	Direct	4 Paxman dryback	5 Peache	5 Parker
167	MANCHESTER	Corporation	1893	G. F. Metzger	100, 200, & 400	Direct Direct 50~, 3-ph. 6,500 volts	*Dickinson Street*:—18 Lanc., 4 B. & W., stokers, jet. cond., econ. *Bloom Street*:—11 B. & W., stokers, surf. cond., econ. *Stuart Street*:— B. & W., stokers, jet and surf. cond., elg. trs., econ.	4 Galloway, 5 Goodfellow, 2 Musgrave, 2 Ferranti, 2 Parsons turbo. 4 Musgrave 6 Yates & Thom, 2 Wallsend Slipway, 3 Willans	6 Mather & P mens, 2 West 4 Westinghouse 11 Electrical Co
168	MANSFIELD	Corporation	1903	E. Holcombe Hewlett	240	Direct	3 Lanc., 2 water-tube, econ., Proctor stokers, Ledward ejector cond., forced draught	Alley & McLellan, triple exp. dble. acting	2 Parker
169	MARCATE & BROADSTAIRS	I. of Thanet Elec. Tram. & Ltg. Co.	1901	R. Humphries	240 & 480	Direct	4 B. & W., econ.	2 Allis hor., 2 Belliss vert.	4 B. T. H.
170	MARKET DRAYTON	The Market Drayton Elec. Lt. & Pr. Co., Ltd.	1902	C. W. Bentley	240		1 Davey Paxman loco., Boby heater	2 Belliss	2 Parker
171	MELTON MOWBRAY	M. M. Electric Light Co.	1900	W. H. Russell	240 & 480	Direct	3 B. & W., suphtrs., stokers, econ., ejector cond.	3 Parsons turbines	3 Parsons
172	MERTHYR TYDFIL	M. Elec. Traction and Ltg. Co.	1901	A. L. Plunket	230 & 460	Direct	4 B. & W., surf. cond.	4 Browett-Lindley vert. comp.	3 Peebles, 1 Sil
173	MEVACISSEY	M. Electric Light. Co.	1893	J. G. Hill	110	Direct	1 Paxman	Paxman under-type engine	1 Crompton
174	MEXBOROUGH	Urban District Council	1902	H. Waring	220	Direct	2 Lanc., feed heaters	2 Alley & Maclellan, 1 Belliss	3 Mavor & Coul

~ = cycles per second.

CONSTANT **E.M.F.** GUARANTEED.
ON
TRACTION AND LIGHTING LOADS
BY THE USE OF THE
HIGHFIELD
AUTOMATIC REVERSIBLE
BOOSTER
WITH A
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Works: SILVERTOWN, ESSEX.

Lindley	2 Holmes, 11 Parker	4,000	2,735	Pritchetts & Gold, 600 amp.-hrs.	Bare cpr., Callender bit. and Siemens armd. dist., Siemens conc. fdr. in ducts.	£252,546	192,453	62,123	12 arc ..	234=1959 H.P.	Ltg. 5d. & 2d. or 4½d., pr 2d. to 1d.	Max. demand fl. r. & s. c.	2,385,577	3
.. ..	3 G. E. Co., 2 Dick Kerr	1,600	805	E. P. S., 600 amp.-hrs. ..	Conc. armd. fdrs., solid dist., Henley	£76,000	38,230	19,311	44 arc, 807 inc	28=137 H.P.	3d. & 2d. or 5d. ..	Max. demand or flat rate	772,188	
Electric	Power Co.	..	..	.. ..	Callender, laid solid	..	..	..	..	..	Ltg. 4½d., pr. 3d...	Flat rate ..	..	
. ..	2 J. P. Hall	20	16	D. P., 27 H.	Callender, 2 and 3 core lead covd. and armd. direct									
..	4 A. E. G.	690	..	400 amp.-hrs.	Ppr., lead covd., solid in wood, Johnson & Phillips ..	..	..	..	..	..	Ltg. 6d. to 4½d., pr. 2d. to 1½d.	Flat rate with discount ..	..	
. ..	4 Brush..	300	66	420 amp.-hrs., 280 amp. max.	Fdrs. triple conc., dist. 3-core, solid	..	3,069	387	..	8=17 H.P. ..	Ltg. 7d. & 1d., pr. 4d. & 1½d.	Max. demand	..	
. ..	3 Parker..	440	140	Tudor, 35 KW. for 10 hrs. ..	Jute, lead covd., & vulc. bit., single, Callender solid ..	£38,000	8,000	2,300	24 arc, 48 inc.	30=124 H.P.	Ltg. 7d. & 3d. or 5d., pr. 2½d. to 1½d.	Max. demand & flat rate	139,000	3
. ..	2 Johnson & Phillips..	72	..	Tudor, 20 KW. for 5 hrs. ..	Triple conc., B.I.W.	..		Not yet completed			6d. & 3d.	Flat rate ..	..	
bine ..	2 Kapp	60	..	.. ..	V. r. underground and overhead	..	..	..	..	..	6d.	Flat rate ..	..	
. ..	3 Mordey, 2 Parsons	1,050	..	Chloride, & Pollak, 750 amp.-hrs.	Armd., lead covd., conc. ; sep. power cables, 3-core lead covd., solid, B.I.W.	..	..	..	..	..	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand with disc.	343,594	
urbine,	2 Mordey, 1 Ferranti	169	79	.. ..	Callender and St. Helens armd. conc. fdrs., Callender lead covd. conc. dist.	..	3,200	..	3 inc. ..	..	5d.	Contract & flat rate	..	
& Platt	2 Laurence Scott, 5 G. E. Co. ..	520	250	Chloride, 30 KW. for 5 hrs. ..	Fdrs. jute, conc. lead covd. in ducts. & armd. direct ; dist., triple conc. armd. direct, ppr. B.I.W. solid	£45,081	15,219	3,203	22 arc, 470 inc.	25=109 H.P.	Ltg. 5d. & 4½d., pr. 3d. & 1½d.	Flat ra e ..	323,175	3
. ..	5 Laurence Scott	690	300	80 amps. 5 hrs., 120 amps. 3 hrs.	Henley single lead covd. solid in wood	£50,000	4,050	4,050	100 arc ..	11=25 H.P.	Ltg. 5½d., pr. 2½d.	Flat rate with d.sc.	..	
. ..	10 Siemens	630	332	.. ..	Armd. conc. Siemens laid direct	£82,784	25,767	2,882	76 arc ..	7=20 H.P...	Ltg. 6d. & 3d., pr. 3d. & 2d.	Max. demand & flat rate	392,962	5
Belliss	3 Brush, 1 Mather & Platt, 5 Westinghouse	1,200	650	.. ..	Callender	£55,195	31,640	3,625	34 arc, 68 inc.	46=100 H.P.	Ltg. 5d., pr. 3d. ..	Flat rate ..	393,950	4
..	2 Mordey	80	60	.. ..	B.I.W. armd. direct and solid, and bare copper.. ..	..	2,200	..	14 arc, 125 inc	.	2d. to 8d.	Contract & meters	..	
. ..	5 Chamberlain & Hookham	350	151	E. P. S. 1,000 a.-h., Hart 1,500 a.-h.	Jute, lead covd., fdrs. armd., dist. solid, Callender ..	..	13,810	3,692	..	11=19½ H.P.	Ltg. 7d. & 3½d. or 6d., pr. 4d.	M. d., Hop. & flat rate*	..	
ges, 12	4 Ferranti, 9 E. C. C., 3 Fowler ..	8,740	4,126	.. ..	B.I.W., Henley and Silvertown	£338,098	194,114	58,312	93 arc ..	382=1,437 H.P	Ltg. 4d., pr. 1½d. to 2d.	Ltg. flat rate, pr. max. dem.	4,449,650	3
. ..	4 Ganz, 2 Brush	3,400	1,789	.. ..	Paper conc.	£216,282	130,163	28,302	..	72=192 H.P.	Ltg. 4d., pr. 2d. ..	Flat rate ..	1,425,713	3
. ..	4 Mather & Platt	250	264	Chloride, 150 KW. for 1 hr. ..	Triple conc., B.I.W., Johnson & Phillips, and Anchor Cable Co.	£22,000	11,875	2,472	..	75=532½ H.P	Ltg. 7d. & 2½d. or 5d., pr. 3d. & ½d.	Max. demand & flat rate	344,898	2
. ..	7 Silvertown	1,000	546	E. P. S. 720 amp.-hrs. ..	Triple conc., ppr., direct with steel plates, and solid in wood	£70,000	35,117	8,685	223 arc ..	78=416 H.P.	Ltg. 4d., pr. 1½d.. .	Flat rate with disc.	..	
en ..	3 Mordey	210	78.5	Hart, 10 KW. for 6 hrs. ..	Western Electric solid	£22,677	4,638	1,638	..	5=18½ H.P.	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand	42,842	5
. ..	5 Mather & Platt, 1 A. E. G. ..	1,572	779	125 KW. for 4 hrs.	Armd. conc., also lead covd. in ducts for dist.	£125,000	40,248	7,444	72 arc, 529 inc.	20=42½ H.P.	Ltg. 5d. & 2d., pr. 5d. & 1d.	Max. demand	1,005,057	3
. ..	4 Siemens	240	35	.. ..	Bare copper	..	1,000	50	..	..	10s. per 8 c.p. ..	Contract ..	..	
. ..	3 A. E. G.	..	..	.. ..	Fdrs. conc., dist. single, laid solid..	..	..	..	..	..	Ltg. 5d., pr. 2d. ..	Flat rate ..	..	
. ..	7 Laurence Scott	798	331	Chloride, 300 amp.-hrs. ..	V. bit. armd., conc. and triple conc., Callender	£35,550	20,960	3,931	30 arc, 107 inc.	39=79 H.P...	Ltg. 6d. & 2½d., pr. 4d. & 1d., or 2½d.	Max. demand & disc.	339,626	
. ..	66 Siemens & E. C. C.	21,190	10,539	K. L. P. type, E. P. S. ..	Callender solid..	£1,336,709	441,848	79,868	174 arc, 56 inc.	827=2,877 H.P.	Ltg. 3½d. & 3d., pr. 2d. & 1½d., tr. 1.2d.	Sliding scale	23,186,083	1
..	3 Parker, 1 Siemens, 1 Robinson ..	348	234	E. P. S., 35 KW. for 4 hrs. ..	Callender solid..	£46,000	21,032	3,752	18 inc., 4 Nernst.	3=5 H.P. ..	Ltg. 5d., pr. 3d. ..	Flat rate ..	162,468	5
. ..	1 Bertram Thomas	50	..	.. ..	Glover, lead covd. and armd. direct	..	..	..	..	..	Ltg. 6d., pr. 4d. ..	Flat rate ..	..	
llan, 1	1 Siemens, 1 Mather & Platt, 1 Bertram Thomas	250	..	.. ..	Glover conc. and single, B.I.W. & Helsby 2-core, armd. direct	..	..	..	..	..	Ltg. 6d., pr. 6d. to 3½d.	Flat rate and scale	..	
..	4 Silvertown, 2 Crompton	700	412	Pritchetts & Gold, 500 amp.-hrs.	Triple conc. fdrs., armd., lead covd., 3-core dist. direct..	£35,199	16,000	..	48 arc ..	12=75 H.P.	Ltg. 7d. & 2d. or 5d., pr. 2d.	Max. demand & flat rate	309,200	4
..	6 Siemens arc...	150	93.5	.. ..	V. r. single core armoured	£19,786	..	..	183 arc ..	..	.. ..	.. ..	..	
..	2 E. C. C.	300	64	Chloride 40 KW. for 13 hrs...	Vulc. bitumen, solid	£20,992	4,336	2,803	..	14=21½ H.P.	Ltg. 8d. & 2d., pr. 2½d.	Max. demand	58,846 (inc. works)	5
y ..	3 B. T. H., 1 Lanc. Dynamo Co. ..	975	275	Chloride..	V. r. conc. fdrs. and dist., Callender, solid	£58,000	18,274	6,779	70 arc, 232 inc.	13=46 H.P.	Ltg. 7d. & 3d., pr. 2½d.	Max. demand	276,482	5
..	5 Allen	297	128	Chloride, 280 cells, 400 amp.-hrs.	Callender, v. bit. 3-core dist., conc. fdrs. & sing. core diable v. b. c.	£28,103	6,737	2,717	10 arc, 27 inc.	11=38 H.P.	Ltg. 6d. & 3d., or 4½d., pr. 3d. & 1½d.	Max. demand & flat rate	92,690	4
..	2 Parker	124	107*	D. P., 20 KW. for 8 hrs. ..	Callender, triple conc. fdrs., 3-core dist., all armd. ..	£23,000	5,747	2,244	2 arc, 108 inc.	4=6½ H.P...	Ltg. 7d. & 4d., pr. 4d. & 1½d.	Max. demand	65,594	4
Wyss,	2 Mordey, 1 E. C. C.	150	54	.. ..	Diatrine twin and conc., Glover and St. Helens.. ..	£7,500	2,250	400	1 arc, 84 inc.	..	5d.	Flat rate ..	80,491	
worth,*	1 Mordey	35	33	.. ..	Conc. lead covd. and armd.	..	.	24	87 inc. ..	..	4½d.	Flat rate ..	..	
..	5 Parker	675	235	Chloride, 46 KW. for 5 hrs. ..	Callender, solid in iron trg.	£40,090	20,000	13,000	46 arc, 180 Nernst	235 H.P. ..	Ltg. 7d. & 2d., pr. 2d. to 1d.	Max. demand	212,634	3
Mus-turbo. ..	6 Mather & Platt, 4 E. C. C., 1 Siemens, 2 Westinghouse, 2 Parsons	10,350												
	4 Westinghouse	7,200	12,115	Chloride, 480 KW.— hrs. ..	Bare copper, v. r., ppr., and v. bit., Callender, B.I.W., Glover, Western Electric, Johnson & Phillips	£1,791,000	598,659	61,426	29 arc ..	1,025=3,298 H.P.	Ltg. 5½d. & 1½d., pr. 2d. to 1d., sliding scale	Max. demand & sliding scale from 5½d. to 1½d.	17,378,600	3
l Slip-	11 Electrical Co. (A. E. G.)	16,000*												
o. dble.	2 Parker..	400	..	1,000 amp.-hrs.	Western Electric, triple conc. ppr. lead covd., laid solid in c'ware and iron tr.	£50,000	5,000 app. for	..	30 arc ..	12=20 H.P.	Ltg. 7d. & 2d., pr. 6d. & 1d.	Max. demand	..	
..	4 B. T. H.	1,000	..	Tudor, two, 560 amp.-hrs. ..	B.I.W., conc.	..	..	..	60 arc ..	..	6d. & 3d.	Max. demand	..	
..	2 Parker..	90	40	Pritchetts & Gold, 400 amp.-hrs.	Call. fdrs. armd. b. fibre, ld. shld., dest. 3-core l., sh. and armd., ld. direct	..	1,981	1,981	..	..	7d. & 4d.	Max. demand	..	
..	3 Parsons	300	118.4	D. P., 350 amp.-hrs.	Callender, lead covd. steel taped, conc. fdrs., 3-core dist.	£30,471	9,220	5,631	5 arc, 159 inc.	20=51½ H.P.	Ltg. 7d. & 4d., pr. 4d. & 1½d.	Max. demand	114,854	3
..	3 Peebles, 1 Silvertown	680	350	Hart, ltg. 250 a.-h., chl. trac. 240 a.-h.	Callender, triple conc. fdr. in C. I. pipes, armd., dest. direct	..	3,500	..	25 inc. ..	2=41 H.P....	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand	380,214	
..	1 Crompton	21	..	Epstein	Bare copper overhead	£1,134	..	..	38 inc. ..	..	7½d.	Flat rate ..	..	
..	3 Mavor & Coulson	200	92	Stockton, 40 KW. for 5 hrs. ..	Callender, solid	£15,000	2,550	All	15 arc, 223 inc.	1=1 H.P. ..	Ltg. 5d., pr. 3d. ..	Flat rate with disc.	102,439	2

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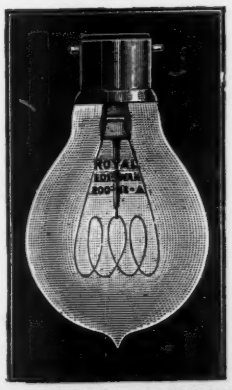

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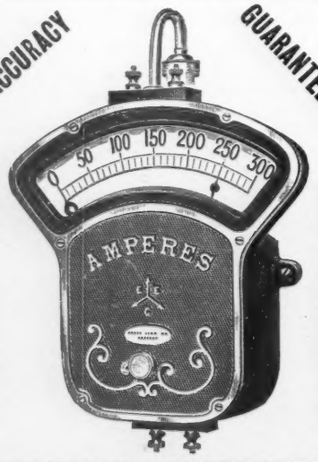
BASTIAN METER Co., Ltd.,
BARTHOLOMEW WORKS,
KENTISH TOWN, N.W.

..d.. ..	100 & 200	Direct ..	.. ..	2 Turbines	2 J. P. Hall	20	16	D. P., 27 H.	Callender, laid solid		
.. ..	200	Direct ..	4 dryback	4 Reavell (2 ltg., 2 ltg. & tr.) ..	4 A. E. G.	690	..	400 amp.-hrs.	Callender, 2 and 3 core lead covd. and armd. direct		
Tooth ..	230 & 460	.. ..	2 B. & W. marine, 1 Fraser dryback	4 Universal	4 Brush..	300	66	420 amp.-hrs., 280 amp. max.	Ppr., lead covd., solid in wood, Johnson & Phillips ..		
Smyth ..	230 & 460	Direct ..	2 Lanc., stokers, econ., ejector cond.	3 Allen, vert. comp.	3 Parker..	440	140	Tudor, 35 KW. for 10 hrs. ..	Fdrs. triple conc., dist. 3-core, solid		
Ritson ..	230 & 440	Direct ..	Fraser's Economic	2 Willans	2 Johnson & Phillips..	72	..	Tudor, 20 KW. for 5 hrs. ..	Jute, lead covd., & vulc. bit., single, Callender solid ..		
.. ..	100	75–, 1-ph.	1 Lanc.	1 Westinghouse, 1 Victor turbine ..	2 Kapp	60	..	.. ..	Triple conc., B.I.W.		
ffiths ..	230 & 460	Direct ..	5 B. & W., Wilson smokeless process and econ.	3 Brush, 2 Parsons turbine	3 Mordey, 2 Parsons	1,050	..	Chloride, & Pollak, 750 amp.-hrs.	V. r. underground and overhead		
Trevor-	100	100–, 1-ph.	1 loco-type, jet cond.	1 Fowler hor. comp 1 turbine, 1 water-wheel	2 Mordey, 1 Ferranti	169	79	.. ..	Armd., lead covd., conc.; sep. power cables, 3-core lead covd., solid, B.I.W.		
er									Callender and St. Helens armd. conc. fdrs., Callender lead covd. conc. dist.		
ing ..	200 & 400	Direct ..	2 Lanc., econ., jet cond., 2 vert. for producer plant.	2 Belliss (steam), 5 Fielding & Platt (gas)	2 Laurence Scott, 5 G. E. Co. ..	520	250	Chloride, 80 KW. for 5 hrs. ..	Fdrs. jute, conc. lead covd. in ducts. & armd. direct; dist., triple conc. armd. direct, ppr. B.I.W. solid		
rancis ..	230 & 460	Direct ..	3 Stirling	5 Browett-Lindley	5 Laurence Scott	690	300	80 amps. 5 hrs., 120 amps. 3 hrs.	Henley single lead covd. solid in wood		
Edgcome..	105	77–, 1-ph.	3 Lanc., 4 B. & W., stokers, suphtrs., surf. cond., econ.	10 Belliss	10 Siemens	630	332	.. ..	Armd. conc. Siemens laid direct		
Tester ..	100 & 200	Direct ..	5 Lanc., 2 Lancs., & destctor.	4 Willans, 1 Westinghouse, 4 Belliss	3 Brush, 1 Mather & Platt, 5 Westinghouse	1,200	660	.. ..	Callender		
Smyth ..	100 & 200	100–, 1-ph.	2 Cornish induced draught	2 Combe Barbour hor. cond. ..	2 Mordey	80	60	.. ..	B.I.W. armd. direct and solid, and bare copper.. ..		
E. Jones	115 & 230	Direct ..	3 Robey loco., cond.	3 Robey comp.	5 Chamberlain & Hookham	350	151	E. P. S. 1,000 a.-h., Hart 1,500 a.-h.	Jute, lead covd., fdrs. armd., dist. solid, Callender ..		
kinson ..	100 & 200	83–, 1-ph., 50–, 2-ph.*	14 Lanc., 10 B. & W., stokers, econ., suphtrs. and cond.	1 Fowler, 2 Hick-Hargreaves, 12 Belliss, 1 McLaren	4 Ferranti, 9 E. C. C., 3 Fowler ..	8,740	4,126	.. ..	B.I.W., Henley and Silvertown	£3	
on ..	100 & 200	50–, 1-ph.	6 B. & W., 5 Lanc.	6 Hick Hargreaves, horiz.	4 Ganz, 2 Brush	3,400	1,789	.. ..	Paper conc.	£2	
Kinghorn	220 & 440	Direct ..	2 Lanc., & 1 water tube	2 Willans, 1 Galloway	4 Mather & Platt	250	264	Chloride, 150 KW. for 1 hr. ..	Triple conc., B.I.W., Johnson & Phillips, and Anchor Cable Co.	£	
Rutherford	230 & 460	Direct ..	4 Lanc., econ.	7 Belliss	7 Silvertown	1,000	546	E. P. S. 750 amp.-hrs. ..	Triple conc., ppr., direct with steel plates, and solid in wood	£	
Bolton ..	230 & 470	Direct ..	3 B. & W., suphtrs, jet. cond., feed htr.	2 Universal vert. comp., 1 Allen ..	3 Mordey	210	78.5	Hart, 10 KW. for 6 hrs. ..	Western Electric solid	£	
Lewis ..	150 & 300	Direct ..	8 Paxman, econ.	6 Willans	5 Mather & Platt, 1 A. E. G. ..	1,572	779	123 KW. for 4 hrs.	Armd. conc., also lead covd. in ducts for dist.	£1	
. Ritter ..	110 & 220	100–, 1-ph.	.. ..	Turbines	4 Siemens	240	35	.. ..	Bare copper		
.. ..	230 & 460	Direct ..	.. ..	3 Westinghouse gas engines.. ..	3 A. E. G.	..	..	.. ..	Fdrs. conc., dist. single, laid solid..		
g	230	Direct ..	5 Marine, econ., water softener	6 Willans	7 Laurence Scott	738	331	Chloride, 300 amp.-hrs. ..	V. bit. armd., conc. and triple conc., Callender	£	
ugh (Res.)	230 & 460	Direct ..	73 Lanc., stokers, 6 econ.	63 Willans	66 Siemens & E. C. C.	21,190	10,589	K. L. P. type, E. P. S. ..	Callender solid..	£1,3	
Horsfall..	220	Direct ..	3 Lanc., stokers, feed htr.	3 Willans, 2 Browett-Lindley ..	3 Parker, 1 Siemens, 1 Robinson ..	348	234	E. P. S., 35 KW. for 4 hrs. ..	Callender solid..	£	
.. ..	230 (2-wire)	Direct ..	1 Cornish	1 Browett-Lindley	1 Bertram Thomas	50	..	.. ..	Glover, lead covd. and armd. direct		
Sears ..	230 & 460	Direct ..	3 Lanc.	1 Willans, 1 Alley & MacLellan, 1 Reavell	1 Siemens, 1 Mather & Platt, 1 Bertram Thomas	250	..	.. ..	Glover conc. and single, B.I.W. & Helsby 2-core, armd. direct		
rton ..	220 & 440	Direct ..	6 B. & W. (2 combined Beaman & Deas destructor) econ.	3 Belliss, 3 Allen, vert. comp. ..	4 Silvertown, 2 Crompton	700	412	Pritchetts & Gold, 500 amp.-hrs.	Triple conc. fdrs., armd., lead cov., 3-core dist. direct..	£	
Macrory ..	3,150 to 2,500	Direct ..	2 Lanc., econ., cond.	3 Brown & Sons, vert. comp. ..	6 Siemens arc..	150	93.5	.. ..	V. r. single core armoured	£	
ngford ..	230 & 460	Direct ..	2 B. & W., econ.	2 Belliss..	2 E. C. C.	300	64	Chloride 40 KW. for 13 hrs. ..	Vulc. bitumen, solid	£	
Bruce ..	230 & 460	Direct ..	4 B. & W., suphtrs., surf. cond.	2 Musgrave, 2 Browett-Lindley ..	3 B. T. H., 1 Lanc. Dynamo Co. ..	975	275	Chloride..	V. r. conc. fdrs. and dist., Callender, solid	£	
Cooke ..	250 & 500	Direct ..	2 Lanc., sf. cond., econ., suphtr., water softener	4 Allen vert. comp.	5 Allen	297	128	Chloride, 280 cells, 400 amp.-hrs.	Callender, v. bit. 3-core dist., conc. fdrs. & sing. core diable v. b.	£	
Salter ..	240 & 480	Direct ..	2 B. & W., suphtrs.	2 Belliss..	2 Parker	124	107*	D. P., 20 KW. for 8 hrs. ..	Callender, triple conc. fdrs., 3-core dist., all armd. ..	£	
Kimmins	100	100–, 1-ph.	1 loco.	1 Sherman (steam), 1 Escher Wyss, 5 Pelton (water)	2 Mordey, 1 E. C. C.	150	54	.. ..	Diatrine twin and conc., Glover and St. Helens.. ..		
onnor ..	2,000	100–, 1-ph.	*	1 portable, Clayton & Shuttleworth,* 1 turbine	1 Mordey	35	33	.. ..	Conc. lead covd. and armd.		
Hoadley ..	230 & 460	Direct ..	4 Paxman dryback	5 Peache	5 Parker	675	285	Chloride, 46 KW. for 5 hrs. ..	Callender, solid in iron trg.	£	
Metzger ..	100, 200, & 400	Direct ..	*Dickinson Street*:—18 Lanc., 4 B. & W., stokers, jet. cond., econ.	4 Galloway, 5 Goodfellow, 2 Musgrave, 2 Ferranti, 2 Parsons turbo.	6 Mather & Platt, 4 E. C. C., 1 Siemens, 2 Westinghouse, 2 Parsons	10,350	12,115	Chloride, 480 KW.— hrs. ..	Bare copper, v. r., ppr., and v. bit., Callender, B.I.W., Glover, Western Electric, Johnson & Phillips	£1,7	
		Direct ..	*Bloom Street*:—11 B. & W., stokers, surf. cond., econ.	4 Musgrave	4 Westinghouse	7,200					
		50–, 3-ph. 6,500 volts	*Stuart Street*:— .. B. & W., stokers, jet and surf. cond., clg. trs., econ.	6 Yates & Thom, 2 Wallsend Slipway, 3 Willans	11 Electrical Co. (A. E. G.)	16,000*					
combe	240	Direct ..	3 Lanc., 2 water-tube, econ., Proctor stokers, Ledward ejector cond., forced draught	Alley & McLellan, triple exp. dble. acting	2 Parker..	400	..	1,000 amp.-hrs.	Western Electric, triple conc. ppr. lead covd., laid solid in e'ware and iron tr.	£	
Hewlett mphries ..	240 & 480	Direct ..	4 B. & W., econ.	2 Allis hor., 2 Belliss vert.	4 B. T. H.	1,000	..	Tudor, two, 500 amp.-hrs. ..	B.I.W., conc.		
Bentley ..	240	.. ..	1 Davey Paxman loco., Boby heater	2 Belliss..	2 Parker..	90	40	Pritchetts & Gold, 400 amp.-hrs.	Call. fdrs. armd. b. fibre, ld. shld., dest. 3-core l., sh. and armd., ld. direct		
Russell ..	240 & 480	Direct ..	3 B. & W., suphtrs., stokers, econ., ejector cond.	3 Parsons turbines	3 Parsons	800	118.4	D. P., 350 amp.-hrs.	Callender, lead covd. steel taped, conc. fdrs., 3-core dist.	£	
Plunket ..	230 & 470	Direct ..	4 B. & W., surf. cond.	4 Browett-Lindley vert. comp. ..	3 Peebles, 1 Silvertown	630	350	Hart, ltg. 250 a.-h., chl. trac. 240 a.-h.	Callender, triple conc. fdr. in C. I. pipes, armd., dest. direct		
Hill ..	110	Direct ..	1 Paxman	Paxman under-type engine	1 Crompton	21	..	Epstein	Bare copper overhead		
ring ..	230	Direct ..	2 Lanc., feed heaters	2 Alley & Maclellan, 1 Belliss ..	3 Mavor & Coulson	200	93	Stockton, 40 KW. for 5 hrs. ..	Callender, solid	£	

ACCURACY GUARANTEED.



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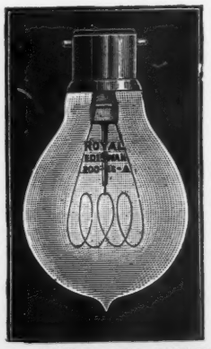

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SINGLEPHA
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GENERA
AND
MOTO
FOR
LIGHTING,
TRACTIO
TRANS
THE . . .
GENERAL EL
LIMIT

.. .. ..	..	..	..	..	..	Ltg. 4½d., pr. 3d...	Flat rate ..	..	..	..	..	..	.. ..	130
d armd. direct	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Flat rate	92,200	..	..	..	..	Water plentiful except during prolonged frost.	131
son & Phillips ..	..	..	..	..	..	Ltg. 6d. to 4½d., pr. 2d. to 1½d.	Flat rate with discount ..	..	..	..	..	..	.. ..	132
.. .. ..	..	3,069	387	..	8=17 H.P. ..	Ltg. 7d. & 1d., pr. 4d. & 1½d.	Max. demand	..	..	..	..	..	.. ..	133
Callender solid ..	£38,000	8,006	2,300	24 arc, 48 inc.	30=124 H.P.	Ltg. 7d. & 3d. or 5d., pr. 2½d. to 1½d.	Max. demand & flat rate	139,000	3.45	1.28	2.66	.. ..		134
.. .. ..	..		Not yet completed			6d. & 3d.	Flat rate ..	..	..	..	..	..	.. ..	135
.. .. ..	..	..	..	..	..	6d.	Flat rate ..	..	..	..	..	..	Management in the hands of the Windermere Co.	136
cables, 3-core lead	..	..	..	..	..	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand with disc.	348,594	..	1.44	..		Lighting and traction	137
ac. fdrs., Callender	..	3,200	..	3 inc. ..	..	5d.	Contract & flat rate	..	..	..	..	..	.. ..	138
s. & armd. direct; B.I.W. solid	£45,081	15,212	3,202	22 arc, 470 inc.	25=109 H.P.	Ltg. 5d. & 4½d., pr. 8d. & 1½d.	Flat rate ..	323,175	3.37	1.08	1.45		Steam and gas station	139
d	£50,000	4,050	4,050	100 arc ..	11=25 H.P.	Ltg. 5½d., pr. 2½d.	Flat rate with disc.	..	..	..	..		Lighting and traction	140
.. .. ..	£82,784	25,767	2,882	76 arc ..	7=20 H.P...	Ltg. 6d. & 3d., pr. 3d. & 2d.	Max. demand & flat rate	392,962	5.094	2.45	5.66	.. ..		141
.. .. ..	£55,195	31,640	3,625	34 arc, 68 inc.	46=100 H.P.	Ltg. 5d., pr. ½d. ..	Flat rate ..	393,960	4.30	1.87	2.41		Erecting new works for lighting and traction	142
are copper.. ..	..	..	2,290	..	14 arc, 125 inc	.	2d. to 8d.	Contract & meters	..	..	..	..	.. ..	143
id, Callender ..	..	13,810	3,692	..	11=19½ H.P.	Ltg. 7d. & 3½d. or 6d., pr. 4d.	M. d., Hop. & flat rate*	..	..	..	..		* Also 2-rate meters used	144
.. .. ..	£328,098	194,114	53,312	93 arc ..	382=1,437 H.P	Ltg. 4d., pr. 1½d. to 2d.	Ltg. flat rate, pr. max. dem.	4,448,650	3.02	.62	.85		No meter rents. * Also 50—, 1-ph. ..	145
.. .. ..	£216,282	130,163	28,302	..	72=192 H.P.	Ltg. 4d., pr. 2d. ..	Flat rate ..	1,425,713	3.87	0.98	1.45		.. ..	146
illips, and Anchor	£22,000	11,875	2,472	..	75=532½ H.P	Ltg. 7d. & 2½d. or 5d., pr. 3d. & ½d.	Max. demand & flat rate	344,898	2.5	1.06	1.31		.. ..	147
lates, and solid in	£70,000	35,117	8,685	223 arc ..	73=416 H.P.	Ltg. 4d., pr. 1½d...	Flat rate with disc.	..	..	..	..		.. ..	148
.. .. ..	£22,677	4,638	1,638	..	5=18½ H.P.	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand	42,842	5.12	2.74	5.21	.. ..		149
for dist.	£125,000	40,248	7,444	72 arc, 529 inc.	20=42½ H.P.	Ltg. 5d. & 2d., pr. 5d. & 1d.	Max. demand	1,005,057	3.31	1.073	1.522	.. ..		150
.. .. ..	..	1,000	50	..	..	10s. per 8 c.p. ..	Contract ..	..	..	..	..	..	.. ..	151
.. .. ..	..	..	..	..	..	Ltg. 5d., pr. 2d. ..	Flat rate ..	..	..	..	..	..	.. ..	152
Callender	£35,550	20,960	3,931	30 arc, 107 inc.	39=79 H.P...	Ltg. 6d. & 2½d., pr. 4d. & 1d., or 2½d.	Max. demand & disc.	339,626	..	..	..	..	.. ..	153
.. .. ..	£1,336,709	441,848	79,868	174 arc, 56 inc.	827=2,877 H.P.	Ltg. 3½d. & 3d., pr. 2d. & 1½d., or 1.2d.	Sliding scale	23,186,088	1.89	.71	.92		Lighting and traction. Data to Dec. 31st, 1902	154
.. .. ..	£46,000	21,032	3,752	18 inc., 4 Nernst.	3=5 H.P. ..	Ltg. 5d., pr. 3d. ..	Flat rate ..	162,468	5.20	1.86	3.13		* Gt. Crosby and Waterloo	155
.. .. ..	..	..	..	..	..	Ltg. 6d., pr. 4d. ..	Flat rate ..	..	..	..	..	..	.. ..	156
lsby 2-core, armd.	..	..	..	..	..	Ltg. 6d., pr. 6d. to 3½d.	Flat rate and scale	..	..	..	..	..	.. ..	157
-core dist. direct..	£35,199	16,000	..	48 arc ..	12=75 H.P.	Ltg. 7d. & 2d. or 5d., pr. 2d.	Max. demand & flat rate	309,200	4.07	1.6	..		Max. load in summer	158
.. .. ..	£19,786	..	..	183 arc ..	..	..	..	..	..	..	..		Only public arc lighting undertaken except 19 private lamps	159
.. .. ..	£20,992	4,336	2,803	..	14=21½ H.P.	Ltg. 8d. & 2d., pr. 2½d.	Max. demand	58,846 (inc. works)	5	1.91	..		.. ..	160
solid	£58,000	18,274	6,779	70 arc, 232 inc.	13=46 H.P.	Ltg. 7d. & 3d., pr. 2½d.	Max. demand	276,482	5	1.75	2.20		.. ..	161
fdrs. & sing. core	£28,103	6,737	2,717	10 arc, 27 inc.	11=38 H.P.	Ltg. 6d. & 3d., or 4½d., pr. 2d. & 1½d.	Max. demand & flat rate	92,690	4.06	1.57	2.71		.. ..	162
st., all armd. ..	£23,000	5,747	2,244	2 arc, 108 inc.	4=6½ H.P...	Ltg. 7d. & 4d., pr. 4d. & 1½d.	Max. demand	65,594	4.65	2.2	3.		* Coronation; 64 normal	163
St. Helens.. ..	£7,500	2,250	400	1 arc, 84 inc.	..	5d.	Flat rate ..	80,491	..	..	..		.. ..	164
.. .. ..	..	.	24	87 inc. ..	..	4½d.	Flat rate ..	..	..	..	..	..	* In course of renewal	165
.. .. ..	£40,090	20,000	13,000	46 arc, 180 Nernst	235 H.P. ..	Ltg. 7d. & 2d., pr. 2d. to 1d.	Max. demand	212,634	3.26	1.636	2.496		Supply to tramways later	166
Callender, B.I.W., & Phillips	£1,791,000	£98,659	61,426	29 arc ..	1,025=3,298 H.P.	Ltg. 5½d. & 1½d., pr. 2d. to 1d., sliding scale	Max. demand & sliding scale from 5½d. to 1½d.	17,378,600	3.48	1.08	1.55		Corporation tramways supplied from Dickinson St., Bloom St., and Stuart St. Works. Plant installed for 800 cars. * 7,500 KW. under constructn.	167
d covd., laid solid	£50,000	5,000 app. for	..	30 arc ..	12=20 H.P.	Ltg. 7d. & 2d., pr. 6d. & 1d.	Max. demand	..	..	..	..		Lighting and traction, destructor attached	168
.. .. ..	..	..	..	60 arc ..	..	6d. & 3d.	Max. demand	..	..	..	..		Lighting and traction	169
dest. 3-core l., sh.	..	1,981	1,981	..	..	7d. & 4d.	Max. demand	..	..	..	..		.. ..	170
conc. fdrs., 3-core	£30,471	9,220	5,631	5 arc, 159 inc.	20=51½ H.P.	Ltg. 7d. & 4d., pr. 4d. & 1½d.	Max. demand	114,854	3.71	1.45	2.56		.. ..	171
pipes, armd., dest.	..	3,500	..	25 inc. ..	2=41 H.P...	Ltg. 7d. & 2½d., pr. 4½d. & 1½d.	Max. demand	380,214	..	..	..		Lighting and traction. Highfield booster	172
.. .. ..	£1,134	..	..	38 inc. ..	..	7½d.	Flat rate ..	..	..	..	..		.. ..	173
.. .. ..	£15,000	2,550	All	15 arc, 226 inc.	1=1 H.P. ..	Ltg. 5d., pr. 3d. ..	Flat rate with disc.	102,439	2.85*	1.35	2.22		Worked in conjunctn. with destructor. * Includes maintnce. of public lamps	174

"Witton"

TINUOUS,
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& POLYPHASE
ENERATORS
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MOTORS
HTING,
TRACTION, AND
TRANSMISSION.

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PER CENT.

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BARTHOLOMEW WORKS,
KENTISH TOWN, N.W.

Western Electric Co.

CABLES,
RUBBER WIRES,
MOTORS.

WESTERN ELECTRIC Co.
(Late Fowler Waring Cables Co),
171, QUEEN VICTORIA STREET, E.C.,
AND
NORTH WOOLWICH, E.

CHICAGO, NEW YORK, PARIS,
ANTWERP, BERLIN, ETC.

If a box becomes inoperative, the Corporation will have to replace it; and, in short, it will devolve upon the Corporation staff to do whatever repairs or supervision is necessary. It is further stated that the Lorain Co. have removed the reserve "parts" which they had at the Corporation tram depôt, and that they have also taken off the line the servants who used to test the contact boxes. The company claim from the Corporation £25,000 for what they have done; and, moreover, they have intimated to the Corporation that they have no right to work the system without the consent of the company. Under these circumstances, the Chairman of the Tramways Committee (Alderman C. T. Mander), the Mayor of the borough (Alderman G. R. Thorne), and the Town Clerk (Mr. Horatio Brevitt) were deputed by the Tramways Committee to wait upon the representatives of the Lorain Co., and endeavour, if possible, to arrange terms on which the company would run the lines as heretofore until the Corporation are in a position to meet the demands of the travelling public. Since then the town clerk has received from the company another letter, pointing out to the Corporation that the company have already continued their supervision and maintenance of the works beyond the period for which they were liable, in order not to cause inconvenience to the public, and referring to proposals which had been made by the Corporation, the letter concludes:—

> My company would have been glad to have been able to adopt your proposals, if only in the public interest; but, in view of the way in which their reasonable request for information has been refused, and the generally unfair treatment they have received at the hands of your Council, they have decided not to agree to your proposals, but to stand strictly by the contract.

It is announced that the company have retained Mr. Fletcher Moulton, K.C., and Mr. Rufus Isaacs, K.C., to represent them at the arbitration, so that evidently there is to be a vigorous fight on behalf of the company. The feeling of the public is that a very serious and grave blunder has been committed by the Corporation in not seeing that a clause was inserted in the contract which would have obviated the present *impasse*, and that the lack of it may lead to most inconvenient and unpleasant developments. Meanwhile the Tramway Committee are preparing for eventualities. They consider they have an adequate staff to cope with the work; they have also a supply of reserve "parts"; and though they have no surplus contact boxes, should any of the existing boxes have to be thrown out they will be replaced by taking up some of the boxes on the unused portions of the routes already laid down—such as the stretch of line at Molineux Grounds, on the Waterloo Road. The Committee do not anticipate any trouble.

The Council on Monday passed a resolution appointing the chairman of the Tramways Committee (Mr. Alderman Mander), the Mayor (Mr. Alderman Thorne), Mr. Alderman Craddock, Mr. Alderman Gibbons, Mr. Councillor Bantock, and Mr. Councillor White, a sub-committee, with whom the town clerk may confer from time to time in regard to any of the matters connected with the forthcoming arbitration between the Corporation and the Lorain Co. The town clerk was also empowered to retain such counsel and experts as he may deem advisable.

At the same meeting an excellent object lesson was given as to state of affairs within the Tramways Committee since the decision of the Council. The following resolution had been placed upon the agenda:—"That the tender of Mr. Herbert Holloway, of Wolverhampton, for the construction of the permanent way of the proposed tramways on the overhead system on the following routes at sums named, be accepted, viz., Dudley Road, £11,247 6s. 8d.; Wednesfield Road, £7,276 18s.; Willenhall Road, £9,654 5s." It seemed the very irony of fate that this resolution should have to be submitted to the Council by the chairman of the Committee, who, above all others, has been instrumental in introducing the Lorain system into the borough, and has always been its most strenuous advocate; but the mandate of the Council must be obeyed, and hence the anomalous position he occupied. Though submitting the motion as a matter of form, he said he did not approve of it, and whilst it was seconded by Alderman Craddock, deputy chairman of the Committee, he, too, acknowledged he would be in the seventh heaven of delight if it were rejected. This led to something in the nature of a "scene," and the resolution was referred back, so that the members might consider the internal affairs of the Committee and put their house in order.

TELEGRAPH AND TELEPHONE NOTES.

Anglo-Belgian Telephones.—The telephone line from London to Brussels was opened for public communication on Monday.

Glasgow Telephones.—The National Telephone Co. wrote some time ago to the Corporation objecting to what they termed a mis-statement of fact by their engineer in styling the Corporation service the larger of the two. The Council agreed to let the communication lie (!) on the table and ignore same, as, on examination, it was found that the Corporation service numbered 9,122 subscribers, and had been in existence 21 months, while the National Telephone Co.'s service numbered 8,600 subscribers, and had been 24 years in existence. The Corporation have issued a circular agreeing to pay terminal charges of subscribers to the extent of £1 per annum per subscriber.

Newport (Mon.) Telephones.—The T.C. has decided to adhere to its decision not to take up the question of municipal telephones if the private company in the town fails to obtain a license. Mr. Bennett offered, if the company failed, to hand over all the signed promises to subscribe, to the Corporation.

Portsmouth Telephones.—On the recommendation of the committee, it is proposed to expend £12,000 upon the extension of the municipal telephone system. The National Telephone Co. are pushing a cheaper service in this town. They now offer an exclusive line service in Portsmouth, with large outward traffic and unlimited inward traffic from £5 a year. A party line service from 2d. per day is also offered.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1902 ..	..
Trinidad-Demerara No. 1	Aug. 27, 1901 ..	..
Trinidad-Demerara No. 2	June 9, 1903 ..	..
Dominica-Martinique	May 8, 1903 ..	..
St. Lucia-Martinique	May 8, 1902 ..	..
Guadeloupe-Martinique	May 9, 1903 ..	..
Martinique-Puerto Plata	July 10, 1902 ..	..
Cayenne-Pinheiro	Aug. 13, 1902 ..	..
St. Lucia-St. Vincent	Sept. 19, 1902 ..	..
Reissa-Issa	Oct. 22, 1902 ..	..
Reissa-Yemani	Oct. 22, 1902 ..	..
Paramaribo-Cayenne	Feb. 27, 1903 ..	..
New York-Haiti	April 13, 1903 ..	..
Assab-Massowah	June 1, 1903 ..	..
Landlines.		
Dagua-Buenaventura..	June 6, 1903 ..	..
All communication with Tonkin interrupted by reason of typhoon	June 9, 1903 ..	..

Wireless Telegraphy.—The Marconi Wireless Telegraph Co. of America has issued official notice to its stockholders setting forth the terms of the agreement with the underwriting syndicate, under which the company is to be supplied with funds for the extension and equipment of the system in the United States. The notice says:—"Many of the large holders of stock have approved the plan outlined in the agreements, and have become parties thereto by depositing their stock. No obligation rests upon any stockholder of the company to deposit stock under the agreement in question."—*Financial News.*

Mr. Austen Chamberlain, the Postmaster-General, replied in the House of Commons on Monday to the criticisms which had been raised in the course of the debate on the vote for the Telegraph Service. After mentioning the assistance which had been rendered to Mr. Marconi by the Post Office in earlier years, and explaining their attitude of recent years, Mr. Chamberlain proceeded:—At present they knew very little about wireless telegraphy. They knew very little of the conditions under which wireless telegraphy would have to be worked. In most countries the Post Office was in the position of a monopolist; but in this country the monopoly of the Postmaster-General did not cover communications with a foreign shore or outside the three-mile limit. The Post Office, therefore, could not strangle the invention even if it wanted to. Their business communications had not been with Mr. Marconi, though personally his relations with that gentleman had been most friendly. They had been dealing with the company which possessed the inventor's rights. The company did not ask merely for what the cable companies had. They asked for an exclusive right to work wireless telegraphy in this country, and they asked for permanence. He could not give them either. He said he would give them a private wire at Poldhu; and when they applied for it they had that private wire, and they had had it for some time past. There was no difficulty at any time about the company's having their private wire on ordinary terms, or obtaining delivery of any messages sent to them from any point in this country, or having messages received at Poldhu put on the Post Office wires. But they asked the Post Office to become their agents for the collection of messages to be transmitted by their wireless system in the same way that anybody could hand in a message at any post office to be transmitted by the cable companies. He wrote explaining generally the terms on which he was prepared to act, and laid down certain conditions he would have to enforce in order to prevent interference with the Admiralty for strategic reasons, and to safeguard national interests. He further said they must satisfy his technical officers of what was disputed by him, namely, that the company were in a position to carry on their business and transmit messages from one side of the Atlantic to the other. That letter was written on March 31st last, and he was still waiting for a reply. He did not complain of the delay in the least; but he did complain that the delay should be attributed to the Post Office.

In the course of his lecture before the Royal Institution last Friday, Prof. Fleming received wireless messages from University College, and from Marconi at Poldhu. He is reported in the daily press as saying at the conclusion of the lecture:—"Wireless telegraphy, in conclusion, ought not to be hampered by hasty or premature legislation. It would not interfere with the work done by the submarine cables or the land telegraphs; it would perform in the future a service of its own, and one which could not be done by telegraphy by wires." This is certainly a very important remark to emanate from one so closely in touch with Mr Marconi.

The Wireless Telegraphy Co., of Berlin, has been formed to exploit the Braun and Slaby-Arco systems with the co-operation of the respective inventors. The new company has concluded manufacturing agreements with the Allgemeine Electricity Co. and the Siemens & Halske Co. The first of these has subscribed one-half of the capital, whilst the second half has been taken up by the Braun Co. for Wireless Telegraphy and the Siemens & Halske Co. The share capital of the new company amounts to £15,000.

It is stated that the De Forest Wireless Telegraph Co. has installed 22 stations in America, and is fitting up 20 more. This system has been installed by the United States Government between Forts Wadsworth and St. Hancock. It is also to be used on the Great Lakes.

CONTRACTS OPEN AND CLOSED.

OPEN.

Beckenham.—June 22nd. Electricity meters. See "Official Notices" June 5th.

Belgium.—June 24th. Tenders are being invited until the 24th inst, by the Belgian State railway authorities at La Bourse, Brussels, for the supply and installation of two 25-ton electric cranes.

Bradford.—June 13th. Tenders are wanted by the Corporation for the lighting of the Cartwright Memorial Hall. Tenders are wanted by the Guardians for the lighting of the Sanatorium for consumptives at Eastly, near Skipton.

Bray.—June 15th. Transformers, mains, and pipework for the electricity works extensions. See "Official Notices" June 5th.

Burma.—June 26th. The Burma Railways Co., Ltd., wants tenders for an electric light and power plant for the Insein workshops. Particulars, specifications, &c., from C. E. Cardew, ocomotive and carriage superintendent.

Colchester.—June 22nd. Feeder cables, overhead equipment and cars. See "Official Notices" June 5th.

Derby.—June 16th. Rails, tie-bars, points, crossings, excavation and other roadwork, poles, overhead wiring, feeders, and cars for the Corporation tramways. See "Official Notices" May 29th.

France.—The French Post and Telegraph authorities have just invited tenders for the electric lighting of the postal vans on the railways during a period of 9 years from November next.

Germany.—Tenders are at present being invited by the Municipal authorities of Graudenz for the supply of a steam dynamo for the Municipal central electric lighting station, at an estimated cost of £2,400.

Gloucester.—June 16th. Generating plant (two 200-KW. sets), condensing plant, pipework, switchboard, battery and boosters for the city light railways. See "Official Notices" May 8th.

Gloucester.—June 16th. Rails, permanent way, cables, pillars, poles, overhead work, cars, trucks, and equipments, for the City Light Railways. See "Official Notices" May 22nd.

Govan.—June 29th. Steam piping, electric pump, &c. See "Official Notices" to-day.

Hull.—June 25th. Steam pipes for the Sculcoates Lane electricity works. See "Official Notices" to-day.

Hungary.—August 31st. Tenders are being invited until August 31st next by the municipal authorities of Besztercebanya (Neusohl) for the establishment in the town of a central electricity generating station of a capacity of 500 H.P.

Johannesburg.—June 15th. Rails, points and crossings, tie-bars, &c., for the electric tramways. See "Official Notices" May 1st.

Launceston (Tasmania).—September 28th. 500 or more electric meters. See "Official Notices" to-day.

London.—June 22nd. Electrical accessories for the Metropolitan Asylums Board. See "Official Notices" to-day.

Manchester.—June 15th. Two groups of three single-phase transformers of 60-KW. each; high-tension cables. See two "Official Notices" June 5th.

New South Wales.—September 12th. Tenders are being invited by the Railway Commissioners for New South Wales, for an additional generating set of 1,500 KW. for their tramway power station. Tenders may be submitted for either reciprocating or turbine engines. Full conditions for tendering are expected to be available at the office of the Agent-General for New South Wales, 9, Victoria Street, S.W., early in July. Tenders close in Sydney on September 12th next.

Portugal.—October 21st. Tenders are being invited until October 21st by the Portuguese Ministry of the Colonies in Lisbon for the concession for the electric lighting of the town of Macao in the Portuguese Colonies.

Rangoon.—July 1st. The Municipal Committee wants tenders for carrying out its electric lighting license, and particulars, forms, &c., can be obtained from the officiating secretary (W. Shircore), Rangoon municipality, at Rs. 75 per set.

Rochdale.—June 25th. Poles, overhead equipment, section boxes, &c. See "Official Notices" to-day.

Rotherham.—June 22nd. Two Lancashire boilers. See "Official Notices" to-day.

Salford.—June 20th. Pilot and telephone wires for the tramway poles. See "Official Notices" June 5th.

Sheffield.—June 25th. Cables for 12 months. See "Official Notices" to-day.

Southend.—June 15th. 10,000 pairs of flame carbons. See "Official Notices" May 29th.

Spain.—June 30th. The Spanish Post and Telegraph authorities in Madrid are inviting tenders until the 30th inst., for the concession for the establishment and working of the telephone lines between Oviedo and Gijon, and between Gijon and San Juan de Nieva. Particulars may be obtained from, and tenders are to be sent to, La Direccion General de Correos y Telegrafos Carretas 10, Madrid.

Stepney.—June 22nd. Meters and demand indicators for a year. See "Official Notices" June 5th.

Stepney.—June 22nd. "Conradty" arc lamp carbons for a year. See "Official Notices" to-day.

Stretford.—June 25th. Arc lamps, &c., for street lighting. See "Official Notices" to-day.

Wood Green.—June 24th. Underground mains, and roadwork for private lighting. See "Official Notices" May 29th.

CLOSED.

Bath.—The contract now being executed for the Bath Electric Tramways, Ltd., by the British Westinghouse Electric and Manufacturing Co., includes the building of the generating station and car-sheds, and the supply, delivery, and erection of the entire equipment for these to designs prepared in conjunction with the company's engineers, Messrs. Harper, Hopkins & McCarter. The generating station equipment is to consist of three 200-KW. Westinghouse compound-wound generators, direct connected to Yates and Thom horizontal, tandem, compound engines, running at a speed of 100 revolutions per minute, and one 75-KW. compound wound Westinghouse direct connected steam set to operate at 300 revolutions per minute. Two 15-KW. negative boosters are to be supplied, with a 12-panel switchboard, of the Westinghouse tramway type, as well as such other auxiliary apparatus as is involved in a tramway generating station. The boiler house is to be equipped with three 10,000-lb. Babcock & Wilcox straight tube, water-tube boilers, and a Clay Cross economiser; surface condensers are to be used, and also a complete equipment of water softening and grease separating apparatus. The car-shed is to have a capacity for 40 double-deck, 56-passenger cars. On the second floor and across the front of the car-shed are to be located the offices of the company The rolling stock is to consist of 40 cars, the bodies and trucks being of the Milnes make, and the equipments the well-known Westinghouse No. 49B/90. Most of the cars will, at the outset, be equipped with the Westinghouse magnetic brake, which should be useful, because of the large number of severe gradients at Bath.

Battersea.—The B.C. has accepted the tender of the British Thomson-Houston Co., Ltd., to supply prepayment electric light meters at the following rates:—100 at £3 10s. each; 200 at £3 7s. 6d. each, or 300 at £3 5s. each.

Bristol.—The following tenders have been accepted by the Corporation Electrical Committee:—Messrs. Doulton & Co., for water softening plant, at £1,171; Messrs. Dick, Kerr & Co., Ltd., for 210-KW. dynamo; Messrs. Siemens Bros & Co., for cables, at £3.327; Messrs. Bumsted & Chandler, for induced draught plant, at £943; Messrs. R. Wilkins & Sons, second instalment of superstructure for the Avonbank Works, at £11,229.

Felixstowe.—The U.D.C. on June 4th accepted the following tenders for supplies to the electricity works:—Messrs. Johnson & Phillips, for arc lamps and columns, at £797, and cables at £945.

Hackney.—The B.C. on 28th ult. accepted the following tenders:—Section X, switchgear, Ferranti, Ltd., £1,792; Section Y, pipework, Ashton, Frost & Co., Ltd., £1,450.

Leek.—The U.D.C. has accepted the following tenders for the supply of plant to the electricity works:—Industrial Engineering Co., for Stockport gas engines and dynamos, at £1,860; Messrs. Thos. Wragg & Son, Swadlincote, for stoneware castings, at £335; Messrs. Wm. Smith & Bros., Ltd., for cast-iron manhole covers, at £42; Callender's Cable Co., for vulcanised bitumen sheathed cables, at £813.

Liverpool.—The T.C. has accepted the following tenders:—Messrs. Babcock & Wilcox, Limited, for the supply of plant for the first section of the new electricity station at Lister Drive at £7,320; Messrs. E. Green & Son, Ltd., of Manchester, for one standard pattern economiser at £657.

London.—The London United Tramway Co., Ltd., has placed the contract for its requirements in electric incandescent lamps for the tramcars for the next 12 months with the Sunbeam Lamp Co.

Maidstone.—The T.C. has accepted the tender of the Reason Manufacturing Co. for the supply of meters for one year at £1 17s. 6d. each.

Rotherham.—The T.C. on June 3rd accepted the tender of Messrs. W. H. Allen, Son & Co., Ltd., for one each 500 and 270-I.H.P. engines and dynamos at the electricity works, at £4,396.

Sunderland. — The British Westinghouse Co. has secured the contract for the electrical equipment of the North-Eastern Marine Engineering Co.'s Sunderland Engine Works. This contract includes the supply of a number of polyphase induction motors of the Westinghouse type "C" constant speed, and type "F" variable speed patterns, together with controlling gear, auto-starters, and three panel switchboard. Power will be obtained from the Sunderland Corporation Supply, for the plant is to be connected up to the new polyphase generating plant, which runs at a pressure of 220 volts, and a periodicity of 50 cycles. The wiring for the installation will also be executed by the British Westinghouse Co. This will include both overhead and underground work, with distribution boxes and conduits.

Thorpe.—The Hart Accumulator Co., Ltd., has secured the contract for a storage battery for the Norfolk County Lunatic Asylum, Thorpe.

FORTHCOMING EVENTS.

Monday, June 15th.—At 7.30 p.m. The Institution of Mechanical Engineers. Graduates' Association. Annual business meeting.

Tuesday, June 16th.—Institution of Civil Engineers. "James Forrest" lecture.

Wednesday, June 17th (also 18th and 19th.)—"Engineering Conference" at Westminster. [See article on another page of this issue.]

Friday, June 19th.—At 9 p m. Royal Institution. Extra Friday evening discourse by Prof. Pierre Curie (Faculté des Sciences à la Sorbonne, Paris) on "Radium" (in French).

NOTES.

The Berlin Chemical Congress.—The total number of papers and reports prepared for this Congress was 456, not "44 reports and 124 papers," as stated by our correspondent last week.

Technical Education in Germany.—Dr. Frederic Rose, H.M. Consul at Stuttgart, has recently sent home a report upon the technical high schools of Germany, to which he ascribes a most important part in aiding the industrial development of the Empire that has taken place during the past 40 years. In 1871 Germany was a country of 39 million inhabitants, 60 per cent. of whom were engaged in agriculture. In 1900 the population was 58 millions, 65 per cent. being concerned in trade and industry, and only 35 per cent.—a smaller absolute number than before—remaining on the land. Prominent among the factors which caused this curious change of occupation and this astonishingly rapid industrial advance are, according to Dr. Rose, the system of protection, the confederation of the German States since 1870, the reduced freights on the State railways and canals, the habits of work, discipline, order, and thrift inculcated by the system of universal military service, and the high standard of general education which prevails in that country. But even when the influence of these and other factors is taken into consideration, the technical high schools have acted most usefully. There are at present nine of these establishments, and two others in process of evolution. They were all founded in the nineteenth century, mostly about 70 years ago, and they are situated in the larger cities of 100,000 inhabitants and upwards, whereas the universities are found in the smaller towns of Germany. Originally the former institutions were founded as trades' schools, and they were intended for the study of architecture, engineering and technical mechanics, with special reference to the purely practical and empirical aspect of these branches. In course of time, however, more attention was devoted to higher mathematics, theory, drawing and design, and new highly specialised and completely equipped departments were opened for chemistry, electricity, various branches of engineering, forestry, photography, naval architecture, pharmacy, surveying, as well as general educational subjects, such as art, philosophy, languages, and political economy. The schools are now intended for the technical education of State and municipal technical officials, and for all persons wishing to qualify themselves for positions in any branch of science applied to industry and trade. The students who attend these schools have passed through the general classical or Real gymnasiums, their average age being from 19 to 21 or 22. As a rule, students of mechanical or electrical engineering must work one year at a machine or in workshops before beginning to study, and if they have not completed their year, they are required to devote their first vacations to making up the time. At some of the schools lists are kept of firms willing to receive apprentices. Students of civil engineering and architecture must also have devoted a certain time to the acquisition of practical experience, but a shorter period is accepted. Students of mechanical engineering wishing to qualify for State positions have to fulfil special requirements in regard to practical work. No compulsion is brought to bear on the students as to attendance at the lectures; but Dr. Rose says that such compulsion is not necessary, because the great majority of the German lads are possessed of only moderate means, and they generally attend the technical schools with a firm intention of devoting themselves to hard work. Considering the quality of the instruction given, and the facilities afforded for doing practical work, the scale of fees is comparatively low, ranging from £12 to £16 per annum for lectures and practical work. The average cost of living at the schools is about £100 a year. From 1870 to 1900 the number of students at German universities, technical, agricultural and veterinary high schools, and at mining and forestry academies, has almost trebled itself. The rate of increase at the different institutions shows that the technical high schools have nearly quadrupled their attendance, while the universities have only increased about 2½ times in their number of students.

Compressed Air as a Cleaner.—The flexibility and efficiency of compressed air as a cleaner of electrical machinery, particularly machinery in motion, is not, says the *American Electrician*, sufficiently appreciated. By no other means is it possible to remove oil-soaked copper or carbon dust without wiping or scraping the coated part. Great care must, of course, be taken to prevent grit or dust being drawn through the pump, as this would work havoc with the surfaces against which the blast is directed. As this is so easily prevented, it cannot be urged as a practical objection to the use of compressed air for cleaning purposes.

The Royal Society.—Among the papers down for reading yesterday was the following:—H. M. Macdonald, F.R.S., on "The Bending of Electric Waves round a Conducting Obstacle: Amended Result."

The Price of Calcium Carbide.—The price of calcium carbide, as fixed by the Nuremburg Syndicate, to which the majority of central European carbide factories belong, is 24·50 marks per 100 kgm. in South Germany, 25·55 at Berlin, and 25·95 at Cologne, for home use only; the price of export carbide is maintained considerably higher. In March the same syndicate sold several tons in Portuguese ports at 40 fr. There are several works in Germany, however, remaining outside the syndicate—*i.e.*, the factories at Gurtnellen, Paternion, and the large works at Terni, in Italy, which makes about 20,000 tons annually, and exports half of it. The exportation of carbide from Germany itself is comparatively small. In Austria-Hungary the price of carbide is 38 k. per 100 kgm. wholesale, the material being guaranteed to give 280 litres of acetylene per kgm. Practically all the works are united in a "Cartell," the factory at Bad-Gastein, which is a derivative of the Neuhausen Aluminium Co., being at the head of the combination. The Paternion Works, which belongs to the Electrical Co., of Venice, is outside this syndicate also; and so is the factory at Jadvoelgy, near Nagy-Varad, which is the only establishment actually situated in Hungary. This last works is very small, however, having only a limited quantity of water-power at its disposal. In France all the works are controlled by the same central agency, and the prices are uniform throughout the country, there being no "free" carbide at all on the market. For lots of 10 tons and upwards the French price is now from 345 fr. at Annecy to 399 fr. at Caen, in drums containing 100 kgm. The amount of carbide consumed in Austria is stated to have been double in 1902 what it was in 1901.

Reheaters in Compound Engines.—Some months ago Prof. Wightman pointed out that there was no economy in steam to be derived by the use of intermediate reheaters in compound engines. In only one case did he find any benefit. The object of the reheater is, of course, to convert into steam the water that has been produced by condensation in the high-pressure cylinder either by conversion of heat into work, or by the peculiar action of the cylinder metal, which is included in the general term cylinder condensation. The conversion of this water into steam can only be effected at the expense of the latent heat of the steam, which is employed to heat the intermediate receiver. It is usually considered that the presence of water in a cylinder is particularly objectionable, and that its abolition avoids a certain cumulative loss. So far, both the experiments of Prof. Wightman, and some recent tests of Mr. Barrus, do not bear out this view. At least it would appear that the low-pressure cylinder does not suffer. Perhaps it never receives water from the receiver; it should not do so if the receiver is well trapped and drained. Mr. Barrus quotes three tests made by him, one on an engine with cylinders 26 in. and 50 in. × 60 in., another on a Corliss engine 18 in. and 40 in. × 48 in., and a third on a Corliss engine with steam-jacketed cylinders 16 in. and 40 in. × 48 in. In the first there was no difference whether steam was or was not used in the reheater, but the engine was enabled to do more work to the extent of 35·5 per cent. In the second case again, the steam consumption remained the same with or without steam in the reheater. The third test confirmed the other two. The L.P. cylinder did 40 H.P. less than the H.P. cylinder, with steam off the reheater, and 18·7 H.P. more power when steam was turned on to the reheater. In all the condensation in the low-pressure cylinder is much reduced, but there is no net gain of economy. But an economy is possible, nevertheless, if only the steam condensed in the reheater is returned hot to the boilers. It leaves the reheater at full boiler temperature, or very nearly so, and ought certainly not to be thrown to waste. By applying a reheater an engine too small for its work may be given more power, and the reheater will give an economy if its drainage is properly saved. Superheating cannot be employed upon an engine that is small for its duty, because superheating prevents the entry of so much steam into a cylinder. Superheat, therefore, demands the power of cutting off the steam admission at a later point. Reheating is evidently not a matter to be undertaken without means of returning the resulting water to the boilers. As with jackets, the proper method of passing steam through reheaters is to have a small boiler at a higher pressure than the other boilers, and to pass all the steam that this special boiler can produce through the reheaters and into the main boilers, thus ensuring the best reheating, perfect circulation and the return of all the water to the boilers. It is only by such means that jackets can be made really effective, and it is due to the non-effectiveness of many jackets that such very different opinions have been held as to the benefits of the jacket.

A Telegraphic Vocabulary.—Many gentlemen are now in London suggesting various methods of overcoming the drawbacks of the official vocabulary and codes in general, to save time in transmission of telegrams and to avoid service errors. It is, of course, difficult to say, without a prolonged study, which scheme is the best and likely to confer the greatest advantages, but it would appear that Mr. James Nicolson's book entitled "Telegraphic Vocabularies adapted to Telegraphic Signals," by example and comparison, shows danger in the use of words as arranged in the vocabulary, and how risks of errors may be avoided. Mr. Nicolson sets forth in his work progress made in the compilation of the vocabulary from the London Conference of 1880 until the present date. The General Post Office at first suggested a vocabulary of 100,000 words, and now the demand has grown to 1,000,000 or more. Mr. Nicolson points out that according to the "Cahier de Propositions, issued by the Central Office of Telegraphic Administrations," Berne, 1901, at pages 42-43, it is proposed to modify Regulation 9 of the St. Petersburg Telegraph Convention, the object being to suppress the interdict against the employment of groups of letters. He also states that his system of vocabulary will entirely obviate the difficulties hitherto encountered in the transmission of fabricated, but none the less phonetically, constructed words, and it is composed of a few convenient letters combined with correspondingly selected signals. He proceeds to show the working of his system, the economy of signals effected thereby, and the comparative immunity from error conferred by it. The book then deals with "Practical Economy," and quotes from the Official Comparative Telegraph Statistics for the year 1899 the number of telegrams of various classes sent by certain States, and the income derived therefrom, and Mr. Nicolson calculates that his system will relieve the cables of from 10 to 50 per cent. of fruitless labour, and after such relief they will be found ample to cope with the increasing demands upon their capacity. It is, of course, known that the public are already employing groups of letters, known as "letter cypher," and there is little doubt but that many merchants have compiled their codes on the gridiron system by the use of letters.

High-Speed Railway Traction in Germany.—A *Times* correspondent says that during the course of the next few weeks there will be witnessed on the Prussian State railways between Hamburg, Hanover and Berlin a highly-interesting competition between steam and electrically-hauled trains. "All the leading locomotive builders and electrical firms in Germany have been invited by the State to submit designs and specifications both for high-speed steam locomotives and also for electric locomotives or motor-cars capable of attaining a speed of 100 miles an hour with a light load and 90 miles an hour in ordinary traffic. The forthcoming tests are to be a continuation of the trials of high-speed electric trains on the Prussian standard gauge military line between Berlin and Zossen, which has just been concluded, and they have been arranged in view of the fact that it has been decided to increase the speed of the trains of the Prussian State railroads running between Hamburg, Hanover and Berlin. Elaborate reports on the Berlin-Zossen tests have been published quite lately by Geheimer Baurat Lochner and Chief Engineer Walter Reichel. In the first trials a car built by the firm of Van der Zypen and Charlier, of Cologne, and electrically equipped by Messrs. Siemens and Halske, of Berlin, actually attained, for a very brief period, a speed of 160·2 kilometres (nearly 100 miles) an hour, but the high-speed tests were abandoned owing to the permanent way giving way, the rails being too weak and the substructure proving not solid enough to bear the weight of the heavy electrical car, which exercised a great wear and tear upon the rails; the total weight of the fully-equipped Siemens & Halske car was over 92 tons. The second series of tests were made with an electric locomotive designed by Mr. Reichel, who, in order to reduce weight, abandoned transformers on the engine and supplied the line voltage of 10,000 volts directly to the motors; in the case of the motor-car the current was transformed down to 1,150 volts; the former weighed 20 tons less than the latter. So far the new electric locomotive has not made higher speeds than 65—70 miles an hour. . . . Doubtless some special form of track is the true solution of the problem of high-speed travel."

The Mercury Coherer.—A Continental correspondent writes as follows:—"At the commencement of the last meeting of the Science Section of the Institute of Geneva, Prof. Thomas Tommasina presented a claim for priority with regard to the system of telephonic reception and the mercury coherer, of which he is the inventor, and which Marconi used during his famous experiment of December 11th, 1901, in the course of which he succeeded in receiving the first signals sent by wireless telegraphy from Europe to America. By mistake, as M. Tommasina affirms, Marconi, before the Royal Society of London, attributed the invention of the mercury coherer to Lieutenant Solari. The editor of the journal *L'Elettricita*, published at Rome, intending to correct this error, committed a fresh one by quoting M. Castelli as the inventor of the new system. The merit of this invention really belongs to M. Tommasina, who was its true inventor, and who brought it before the notice of the Physical Society of Geneva, and published it in the *Comptes Rendus de l'Académie des Sciences* for May 1st, 1899."

Electrical Standardising, Testing and Training Institution.—Prof. C. A. Carus-Wilson commenced a special course of lectures to the senior students of the above institution, upon "Direct Current Motor Construction," yesterday, Thursday, 11th inst.

The M.E.A. Convention.—The full programme of this Convention, which is to be held from July 15th to 18th, is now issued. Briefly the arrangements may be stated as follows:—

Wednesday, July 15th, at 10 a.m., at Sunderland:—
Presidential Address by Mr. J. F. C. Snell.
"Statistics of Electrical Supply," by Aldermen J. P. Smith, chairman of the Barrow-in-Furness Electricity Committee.
"The Possibilities of Future Economies in Electrical Illumination," by W. A. Chamen, Glasgow.
Luncheon given by Mayor and Corporation of Sunderland.
Visits to be paid to—
Wheatsheaf Car Depôt, Monkwearmouth;
Three-Phase Sub-Station;
Dunning Street Electricity Station;
Hylton Road Electricity Station; and
Hylton Road Car Shed and Repairing Shops.
Other places of interest open by kind permission will be—
Messrs. Sir W. T. Doxford & Sons' Shipyard, Pallion, electrically-driven throughout (direct current, from private installation and from Corporation sub-station).
Messrs. the North-Eastern Marine Engineering Works, driven by three-phase induction motors from Corporation's supply.
Messrs. S. P. Austin & Sons' Pontoon, electrically-driven pumps (Corporation supply).
Messrs. Robert Thompson & Sons' Graving Dock, pumps driven from Corporation's supply.
The New Harbour Works of the River Wear Commission.
The National Telephone Co.'s Exchange.

Thursday, July 16th, at Newcastle-on-Tyne, at 10 a.m.:—
"The Sphere of Utility of a Power Company," by Alderman G. Pearson, chairman of the Bristol Electricity Committee.
"Electrical Traction as applied to the Newcastle Tramways," by Mr. A. E. Le Rossignol, chief electrical engineer and general manager, Newcastle Corporation Tramways.
"The Management and Working of Boilers," by Mr. Horace Boot, chief electrical engineer, Tunbridge Wells.
2.30. Visit to Corporation tramways power house, the Manors; and three-phase distributing sub-station of the Tyneside Power Co.; and to the power house of the Tyneside Power Co.
The following places of interest will also be open to members:—
The new Forth Banks station of the Newcastle and District Electric Lighting Co. (Large turbo-dynamos and Stirling boilers.)
Messrs. C. A. Parsons & Co.'s Works, Heaton.
Messrs. J. H. Holmes & Co.'s Works, Portland Road.
Messrs. Scott & Mountain's Works, Newcastle.
Messrs. Clarke, Chapman & Co., Gateshead.
The North-Eastern Marine Works and Sub-Station, Wallsend.
At 8 p.m. the Association Smoking Concert will be held in conjunction with the Local Section of the Institution of Electrical Engineers.

Friday, July 17th, at Middlesbrough, at 10.30 a.m.:—
"Methods of Stimulating Demand," by Councillor J. E. Panton, M.D., chairman of the Bolton Electricity Committee.
"The Financial Improvement of Electricity Supply Works," by Mr. J. A. Jeckell, chief electrical engineer, Coventry.
1 p.m. Luncheon to Members of the Association in the Crypt of the Town Hall, by invitation of the Mayor and Corporation of Middlesbrough.
The following works may be visited during the afternoon:—
Electricity Works of the Corporation.
Messrs. Bolckow, Vaughan & Co., Ltd.
Messrs. Dorman, Long & Co., Ltd.
Messrs. the North-Eastern Steel Co., Ltd.
Messrs. Sir B. Samuelson & Co., Ltd.
The N.E. Railway Co.'s Dock Installation.
And at 5 p.m. visits will be paid to—
The Imperial Tramway Co.'s Three-Phase Power House; and the Stockton Corporation Electricity Works.

Saturday, July 18th, at Sunderland, at 10.30 a.m.:—
The Annual General Business Meeting of the Association.

Electro-Harmonic Society.—We are glad to record that the special extra concert given in the King's Hall, Holborn Restaurant, on Friday evening last, in honour of the foreign delegates to the Telegraph Conference, was an unqualified success. The hall was crowded, and the tasteful toilettes of the ladies combined with the floral decorations to present a charming spectacle. The programme was full of good things from beginning to end. The string orchestra, reinforced by Mr. H. M. Higgs at the Mustel organ, was in brilliant form, and its selections were most happily chosen; Mendelssohn's gossamer-like "Midsummer Night's Dream" overture went splendidly, and seemed to cast quite a spell over the audience. Miss Winifred Marwood and Mr. Montague Borwell sang with much acceptance, particularly in a duet by Goetze. Mr. Percy French was vastly entertaining with his humorous chalk sketches, and Mr. James Taylor spun plates on a table with such bewildering dexterity that one positively longed for the crash that never came. Last, but not least, Mr. Alfred Izard, who for many years has acted as one of the musical directors and accompanist to the Society, deserves praise for his solo, Nicodé's "Tarantelle," and for his finished and artistic accompaniments. Mr. J. Gavey occupied the chair in the unavoidable absence of Sir William Preece. In conclusion, we were very pleased with the superb King's Hall, in which the concert was held; why should not the Electro-Harmonic Society engage this hall for its regular concerts next season? If the extra expense is an obstacle, we feel sure this difficulty would be solved by the large access of new members which would doubtless ensue upon the improved accommodation.

Electric Fire Engines.—In a recent issue of the *Scientific American*, Mr. A. F. Collins gave a descriptive account of the electric fire engine which has been constructed at Rouen. It has an 8-H.P. electric motor, coupled direct to a pump, both of which are on the same plane. The motor makes about 2,000 revolutions per minute, and takes a 525-volt direct current. When the engine is in action the current is tapped by means of a movable bamboo rod, one end of which is fastened to the truck carrying the equipment, and the opposite end is simply placed on one of the overhead trolley wires, or at night contact may be made with the electric lighting cables. The feed wire is rolled on a reel above the motor; the circuit is completed by a similarly-arranged wire wound on an adjacent reel; the free end of this wire terminates in a block of cast-iron placed on one of the rails of the street railway tracks. The apparatus is arranged on a two-wheeled, one-horse cart, and the hose is carried on a separate cart coupled to the electric fire engine. The total weight complete, including two firemen, is 2,288 lbs. Another point which is briefly touched upon by Mr. Collins is the haulage of fire engines electrically instead of by horse or steam. Captain Kenlon, of the Manhattan fire brigade, recently suggested that municipalities in giving franchises to street railway and electric light companies should stipulate in the contract that leads should be run from their circuits to every fire plug on the route. Electric fire engines could then be adopted, the pumps of which could be operated by merely slipping a spring jack into contact with the leads terminating in some portion of the fire plug, while the traction could be obtained by means of a motor and storage battery, just as with automobiles.

The Compound Explosion Engine.—Writing on the explosion engine in *Feilden's Magazine*, Mr. E. Butler points out that for a given initial pressure of, say, 15 atmospheres in a cylinder developing 75 lbs. mean pressure, the weight of the gases is only one-fifth of that of the steam or compressed air that would be required to expand to the corresponding degree. Hence any slight leak in an explosion engine causes great loss. The high mean pressure is due to high temperature, and the pressure is soon lost. The author's idea of a compound engine, is one with two four-cycle explosion cylinders alternately exhausting to a third cylinder, the piston areas being as 1 to 2·2. The first two cylinders have cranks at even angles, and 165° ahead of the third crank, this arrangement producing rapid transfer of the gas and quick expansion. The author considers that delayed combustion assists to reduce the losses due to the cooling jacket. The expansion curve is higher than the adiabatic, whether due to this cause or to the variation of specific heat at high temperatures; no doubt this effect is present, and the result is economy. By means of the second cylinder, the average equivalent extra pressure obtained, is about 10 to 12 lbs. referred to the high-pressure cylinder, thus representing an economy of about 12 per cent. The capacity of the low-pressure cylinder is such that the gases expand to the atmospheric pressure at about five-eighths or three-fourths of the stroke. The partial vacuum then produced, draws out the explosion gases from the explosion chambers. With benzoline, the engine ran better when the products were still left in the combustion chamber. With town's gas, only 13 cb. ft. per I.H.P.-hour were used, and with benzoline, 6 gallons developed 80 H.P.-hours, or 1 B.H.P. with 0·51 pint, and 1 I.H.P. with 0·4 pint. The engine was of about 100 H.P. ordinarily, and the second cylinder gave 18 to 20 H.P. when run with benzoline. The author spoils his article by speaking of certain communications being "functioned" by one rotative balanced valve for all three cylinders. Why so ugly an Americanism should be used in a "militantly British" magazine, in place of decent English, is not very clear.

Obituary.—On Saturday morning last a sad accident occurred at the Dudbridge Ironworks, near Stroud, Glos., which, we regret to say, caused the death of Mr. James D. Humpidge, the managing director, and an engineer's apprentice named French. A new gas engine of 120 B.H.P., which had been built to the order of a Madrid firm, was under test, when the fly-wheel burst. Mr. Humpidge, who was watching the test operations, was so seriously hurt about the head and stomach that on removal to Stroud Hospital he succumbed to his injuries. The apprentice, who, it is said, was tightening up a bearing when the accident happened, was killed on the spot. It is stated that the engine had been running for an hour or so, and the accident is unexplained, except by the supposition of an undiscovered flaw in the metal. Mr. Humpidge was president of the Gloucester Engineering Society, and his presence will be sadly missed in the locality. Less than two years ago we made an interesting visit to the works under the guidance of the deceased gentleman.

We have to record the death of that eminent railway manager, Sir Allen Sarle. He had been in the service of the L.B. & S.C. Railway for 54 years, entering at the age of 21, and remaining associated with the undertaking right up to the time of his death. He was also latterly a director of numerous other companies, including the Great Northern and City Railway Co., the West London Extension Co., and the W. R. Sykes Interlocking Signal Co.

Wages at Home and Abroad.—In the course of his speech to the shareholders in Brunner, Mond & Co. at Liverpool on 27th ult., Sir John Brunner, M.P., said that the wages paid in England were higher than in all protectionist European countries. For every 100s. received by the English artisan, the wages in France were 77s., and the hours of the French workman were half as long again as the Englishman's. In Germany the figures were 78s., and there a man had to work every day half as long again as the Englishman. It took the Frenchman 124 hours and the German 131 hours to turn out the same work as the English artisan did in 100 hours.

Niagara.—The contract for driving the tunnel tail-race for the Toronto and Niagara Power Co. has been awarded to Anthony C. Douglass, of Niagara Falls, N.Y. This will be the third tunnel to be constructed for the development of the energy of the Falls of Niagara. It will be located on the Canadian side of the river, and will extend from the wheel-pit, which is yet to be commenced, to the lower river. In length it will be about 2,100 ft., in height 25 ft., and in width about 18 ft. Thus its section will be slightly higher than any tunnel yet built at Niagara, but in width it will be about the same as the other tunnels. It will afford tail-race facilities for the development of about 125,000 H.P. It will be lined from the portal to the pit. The power house of the Toronto and Niagara Power Co. will be located up the river, a short distance above the station of the Canadian Niagara Power Co., but it will be down stream from the forebay of the Ontario Power Co. Thus its intake will be between these other intakes. Our Niagara Falls correspondent says that Mr. Douglass, who has received the contract, has had considerable experience in rock work at Niagara. He aided in sinking the first wheel-pit of the Niagara Falls Power Co., and he is now building the tunnel of the Canadian Niagara Co. The work of lining this latter tunnel is now in progress. As Mr. Douglass has completed the excavation of the Canadian Niagara Power tunnel he can transfer his plant to the work of driving this new tunnel for the Toronto and Niagara Power Co., both of which works are side by side in Victoria Park. It will take about two years to construct this new tunnel, the contract price for which was about $575,000.

Automobile Legislation.—The last issue of the *Automobile Club Journal* contains the text of the Bill for the registration of motor vehicles, to be introduced into the House of Commons on behalf of the Automobile Club. It contains a number of new clauses. The object of the Bill is to provide for the numbering and registration of motor-cars, light locomotives, and suchlike vehicles, and to enable proper means to be taken under regulations of the Local Government Board for the identification and punishment of persons unlawfully using them. The Bill also provides for the abolition of the specific speed limit and for the licensing of paid drivers of light locomotives.

In view of the recommendation made by various public bodies that all motor-cars should be numbered or bear some other identification mark, a petition to the House of Commons has been drawn up and influentially signed, pointing out that such a course is necessitated by the abuses connected with high-speed motors capable of running long distances without a stop. It is contended, says the *Daily Telegraph*, that the arguments which apply in the case of these cars have no bearing on that of electrical carriages for town use, which are incapable of going at more than moderate speeds, and being designed for use in towns only, are not provided with battery power which would enable them to travel over any considerable distance without recharging. The petitioners urge that it is, therefore, unnecessary to provide that ladies and gentlemen who elect to be driven in electric broughams or landaulets, in preference to horse-drawn vehicles, when making calls in London, driving in the park, or attending the opera or theatre, should be required to have attached to the back of their carriage a large disfiguring number or name. Such a provision, it is said, would practically put an end to the use of such vehicles in London. Attention is drawn to the fact that the identification regulations on the Continent do not apply to such vehicles, and there is no argument which can properly be used to require the Local Government Board to depart from the Continental practice in the matter; the improvements wrought in the conditions of town traffic by the use of electric carriages instead of horse-drawn vehicles are also quoted. On these grounds, the petitioners protest against the proposal that the conspicuous marks of identification which it is proposed to place on motor vehicles in general should be attached to electric carriages for town work.

The Engineering Standards Committee.—A Committee dealing with the question of the standardisation of pipe flanges has been formed in connection with the Engineering Standards Committee. Mr. William Maw, who was President of the Institution of Mechanical Engineers when this question was discussed before that Institution, is chairman of the Committee. The Admiralty has appointed Engineer Lieut. A. R. Emdin, R.N., and Mr. W. E. Smith, Superintendent of Construction Accounts and Contract Work. The Institution of Mechanical Engineers has nominated Mr. Ellington and Mr. Henry Davey; the Institution of Electrical Engineers, Mr. Patchell; the North-East Coast Institution of Engineers and Shipbuilders, Mr. J. Tweedy; and the Institution of Engineers and Shipbuilders in Scotland, Mr. John Steven. The following gentlemen have also seats on the Committee:—Mr. R. E. Atkinson, Mr. J. Dewrance, Mr. J. Hopkinson.

Laying out Armature Windings.—Why does the old custom persist of considering the single conductors, or groups of conductors, in determining the "scheme" of a drum armature winding? It is not necessary to design the winding on the basis of pitch in terms of conductors, or even to consider the pitch at the back end of the armature. In practice it is more convenient to consider the coils instead of the conductors, and the connecting pitch in commutator segments instead of in armature conductors. This is not an academic result, but the result of practice in the use of both methods. With the exception of machines of enormous size an armature coil does not consist of three or four pieces of copper joined together, but of a single strip bent to the required shape. Nothing, therefore, is to be gained by running a winding department on the old lines and dealing with two or three pitches in the windings.—*American Electrician.*

Heat and Cold.—Dr. Carl von Lindé has recently delivered an interesting short address upon the practical value of liquid air to the Ice and Cold Storage Association, of London. Air is not liquefied by electrical means, and is not used for electrical purposes, so that apparently it is a matter which does not concern us directly in the ELECTRICAL REVIEW. But reading the article through, we cannot help being struck by a curious analogy between liquid air and the electric furnace. Dr. Lindé ridicules the prophecies which were freely made some time ago to the effect that all industrial operations where reduction of heat is requisite would in future be carried out by means of the auto-evaporation of liquid air—prophecies which resemble those offered about the entire supersession by electricity of coal and gas firing. In industry most operations requiring artificial heat require large quantities of comparatively low-temperature heat, just as practically all operations requiring artificial "cold" require large quantities of comparatively high-temperature "cold." Below a certain high temperature it is most economical to obtain heat from coal or gas firing, just as above a certain low temperature it is more economical to obtain "cold" by the older and existing methods; but above a certain high temperature electricity is the only economical, and, indeed, possible, source of heat, exactly as below a certain low temperature liquid air is the best source of "cold." It does not pay to raise steam by electric current, and it would not pay to freeze mutton or to chill beef with liquid air. Except for very special purposes—at present only scientific investigation—liquid air is an impossible kind of material to handle. It cannot be kept in sealed vessels, because its critical temperature is as low as −140° C.; so that when the interior of a vessel holding it reaches that temperature, the air changes to a gas which, at atmospheric temperature, exerts a pressure of about 800 atmospheres. Air can only be kept in a liquid condition in open vacuum-jacketed vessels where its temperature is maintained below its critical point by its own evaporation, and this means gradual loss—say, one quart in 14 days.

Personal.—Mr. H. S. Meyer, designing engineer, Alternating Current Section, of the British Thomson-Houston Co., Ltd., Rugby, has returned from an extensive tour in the U.S.A., made in the interests of the B.T.H. Co.

Mr. Thos. Tate, assistant traffic superintendent at Newcastle-on-Tyne, has been appointed traffic superintendent for the Shipley and district electric tramways.

Mr. L. Newitt, who for some years has been chief electrical engineer at the Elswick works of Messrs. W. G. Armstrong, Whitworth & Co., has been appointed by the Lords Commissioners of the Admiralty to be electrical engineer at Chatham Dockyard.

Appointments Vacant.—An assistant in the mechanical and electrical engineering department at the Halifax Municipal School (£150); assistant engineer for Chesterfield (£104); electricity works clerk at Southend; switchboard attendant for Portsmouth tramways power station; chief assistant engineer for Hastings electricity works (£120); lecturer and demonstrator for the Croydon County Polytechnic; clerk of works for Atherton; Government electrician for the Gold Coast Government Railway, at £300; shift engineer for Battersea (£104); dynamo attendant for West Ham Infirmary; and three shift engineers for Reading tramways power station. See "Official Notices" to-day.

Business Announcement.—Messrs. Evershed and Vignoles, Ltd., give notice that they are completing the removal of their business to the new factory which they have built at Acton Green, Chiswick; and that on and after Monday, June 15th, 1903, all letters and goods should be addressed to their new address, Acton Lane Works, Chiswick, London, W.

Mr. Chamberlain's Scheme.—The difficulties which surround the attempt to impose preferential duties are well exemplified by a question put to Mr. Chamberlain by Mr. C. A. Vince, secretary of the Birmingham Liberal Unionist Association, as to the effect of the proposal to levy, if necessary, retaliatory duties on imports from Germany. The special case put by way of example was that of electrical machinery. It had been suggested that if retaliation took the form of a tax on imported machinery, the manufacturers who used such machinery would have a sort of right to call for a duty upon imports that competed with their products, and that such a duty would be purely protective. Mr. Chamberlain, through his secretary, replied that he would not propose to put any tax on German machinery merely because it was cheaper than English, but if he found that German machinery was receiving a bounty—either direct or indirect—he would then be perfectly ready to put on a corresponding duty. Mr. Chamberlain would adhere in every case to Cobden's principle of free interchange at the natural price. According to this, if he did put on a duty, it would not necessarily give a claim to any other manufacturer. If Mr. Chamberlain found that the Germans earned their success legitimately, he would leave the home manufacturers to find out how they did it and to beat the Germans with their own weapons.

Mr. Vince subsequently put a further question, viz., Whether the word "legitimately" is to be interpreted so as to exclude as illegitimate the advantage, if any, that the German manufacturer may have in the absence of such restrictions as are imposed on English manufacturers by Factory Acts and by the approved rules of the trade unions. Is sweating a form of unfair competition that may be countered by an import duty? To this question Mr. Chamberlain answers, "Yes."

Anxious as everyone is to put a stop to unfair competition, we fear that an "indirect bounty" would be difficult to define, and that a "legitimate success" would be just as much a matter of opinion as the "legitimate drama." Considering that all our manufacturers are, or will be, employing electrical machinery, the claims for "grants in aid" would be endless.

THE CENTRAL STATION ENGINEER.

THE Electricity Committee of Manchester T.C. has recommended the following increases of salary:—Mr. S. L. PEARCE, deputy chief engineer, from £500 to £600 per annum; Mr. F. E. HUGHES, secretary, from £400 to £450; Mr. L. R. LEE, mains engineer, from £300 to £325; Mr. W. E. FODEN, accountant, from £250 to £300; Mr. J. A. COOKSON, surveyor of mains, from £250 to £275; Mr. E. BOLTON, sub-station engineer, from £200 to £225; Mr. F. H. WHYSALL, resident engineer at the Dickinson Street works, from £175 to £200; Mr. W. A. JACKSON, installation inspector, from £180 to £190; Mr. I JOHNSON, accounts and wages pay clerk, from £180 to £190; Mr. B. BENNISON, assistant accountant, from £164 to £180; Mr. S. CHARLESWORTH, chief works clerk, from £160 to £180; Mr. A. E. M'KENZIE, shift engineer, from £150 to £180; Mr. H. LAMB, shift engineer, from £150 to £180; Mr J BAXENDALE, shift engineer, from £150 to £180; Mr. A. N. MOORE, shift engineer, from £150 to £180; Mr. E J. CONSTABLE, shift engineer, from £150 to £175; Mr. W. J BAMBER, shift engineer, from £150 to £175; Mr. H. A. RATCLIFF, testing assistant, from £150 to £175.

Mr. J. C. WHITELEY, the chief assistant engineer at the Huddersfield tramways power station was, on June 4th, presented with a timepiece and ornaments on the occasion of his marriage. Councillor MOORE, the chairman of the Tramways Committee, made the presentation. Mr. WHITELEY was made the bearer of a workbasket for the future Mrs. WHITELEY. Mr. H. N. THOMAS, the engineer and manager of the tramways, presided, and in the course of his remarks, expressed the hope that there would be a few more gatherings of the same character.

Out of 100 applicants, Mr. MORGAN, of Worcester, has been appointed to succeed Mr. PROCTOR as electrical engineer to Horsham U.D.C. at £175.

Barnsley T.C. has granted the following increases of salary:—Mr. BARKER, assistant to the borough electrical engineer, from £150 to £170 per annum; Mr. WRIGHT, assistant to the electrical engineer, from £125 to £145.

Batley T.C. has appointed Mr. A. STREET as assistant engineer at the Electricity Works.

Rochdale T.C. has increased the salary of Mr. C. C. ATCHISON, resident electrical engineer, from £200 to £250 per annum, and has granted him £50 for extra services in connection with the electrification of the tramways.

Mr. W. CLITHEROW SMITH, assistant at the Folkestone Electricity Works, has resigned his post in order to take up an appointment with the British Westinghouse Co.

The Electrical Committee of Bristol T.C. has recommended that the salary of Mr. W. B. MORGAN, mains superintendent, shall be increased from £156 to £180 per annum as from June 1st.

The T.C. of Eastbourne has raised the salary of its electrical engineer, Mr. J. KEMPE BRYDGES, from £350 to £400 per annum.

Maidstone T.C. has increased the salary of the electrical engineer (Mr. HOADLEY) from £250 to £300 per annum as from March 25th last.

NEW COMPANIES REGISTERED.

Alley & Maclellan, Ltd. (5,370).—This company was registered in Edinburgh on June 3rd, with a capital of £130,000 in £1 shares, to acquire the business carried on by Alley & Maclellan, and to carry on the business of engineers, iron and brassfounders, shipbuilders, marine and electrical engineers, workers of wood, stone, brick, rubber and other substances, makers of roofs and bridges, pneumatic and sanitary appliances, &c. The first subscribers (each with one share) are:—P. J. Dunlop, Port Glasgow, Renfrewshire, engineer; S. E. Alley, Sentinel Works, Polmadie, Glasgow, engineer; K. M. Alley, Sentinel Works, Polmadie, Glasgow, engineer; A. Robertson, Sentinel Works, Polmadie, Glasgow, shipbuilder; J. Maclellan, 260, St. Vincent Street, Glasgow, engineer: J. Reid, 172, St. Vincent Street, Glasgow, solicitor; and W. Shaw, 142, West George Street, Glasgow, solicitor. The number of directors is not to be less than three nor more than seven; the first are D. J. Dunlop, T. A. Paul, S. E. Alley, K. Alley, J. Maclellan and A. Robertson; qualification, 500 shares; remuneration, £1,000 per annum. Registered office, Sentinel Works, Polmadie, Glasgow.

Electric Lamp Renovating Co., Ltd. (77,552).—This company was registered on May 29th, with a capital of £20,000 in £1 shares, to adopt an agreement with P. E. Butler for the acquisition of certain patents, rights, &c., and to carry on the business of lamp manufacturers, electrical, consulting, mechanical and general engineers, machinists, fitters, millwrights, iron, brass and metal founders, glass blowers and manufacturers, cable, conductor and carbon manufacturers, wire drawers, porcelain manufacturers, &c. The first subscribers (each with one share) are:—F. Fanta, 4 and 5, Warwick Court, W.C., consulting engineer; A. J. Pierpoint, 22, Norroy Road, Putney, S.W., gentleman; C. P. Elms, 109, Tiverton Road, South Tottenham, accountant; H. G. Betts, 44, Furnival Street, Holborn Bars, E.C., auctioneer; W. G Chapman, 4, Gray's Inn Square, W.C., solicitor; J. H. Shipley, 4, Gray's Inn Square, W.C., managing clerk; and E. James, 24, Apsley Street, E., electrical engineer. Minimum cash subscription, £500. The number of directors is not to be less than two nor more than five: the subscribers are to appoint the first; qualification, 100 shares; remuneration as fixed by the company. Registered office, 4 and 5, Warwick Court, High Holborn, W.C.

Miller Signal Syndicate (Foreign Patents), Ltd. (77,594).—This company was registered on June 4th, with a capital of £5,000 in £1 shares, to adopt an agreement with G. Failing, G. Robins, H. V. Miller, A. S. Morrison, A. H. Morrison, and H. C. Cooke, to acquire the patents comprised therein, and to carry on the business of makers and installers of railway or other signals according to the "Miller" or other system, electricians, engineers, suppliers of electricity, company promoters, financiers, &c. The first subscribers (each with one share) are:—R. M. Albery, Bridge Road, Chertsey, gentleman; T. B. Harper, 15, Old Jewry Chambers, E.C., solicitor; O. Heinday, 5—6, Great Winchester Street, E.C., merchant; H. E. Hill, 28, Fairmount Grove, Brixton Hill, S.W., cashier; M. Murphy, 31, Victoria Road, Chelmsford, clerk: F. Hopkins, 29, Heron Road, Herne Hill, S.E., clerk, and E. W. Hopton, 44, Tharpe Road, Wallington, clerk. No initial public issue. The subscribers are to appoint the first directors; remuneration, £50 each per annum.

Bastian & Partners, Ltd. (77,601).—This company was registered on June 5th, with a capital of £1,000 in £1 shares, to acquire any interests in patents, inventions, concessions and the like relating to the production, treatment, storage, application, distribution and use of electricity, or to any apparatus therefor, in particular to acquire from C. O. Bastian, of 37, Streatley Road, Brondesbury, the benefit of certain existing inventions in relation to prepayment electric meters, to electric lamps and to locks, to adopt an agreement with the said C. O. Bastian and to carry on the business of suppliers of electricity, manufacturers of batteries, meters and electrical apparatus and accessories, &c. The first subscribers (each with one share) are:—C. O. Bastian, 37, Streatley Road, Brondesbury, electrical engineer; A. E. Salisbury, 64, Pemberton Gardens, N., electrical engineer; H. M. Graham, 11, Queen Victoria Street, E.C., chartered accountant; H. Scholey, 8, Abbey Court, Abbey Road, London, electrical engineer; E. Sayer, 6, Sarre Road, N.W., electrical engineer; H. T. Harrison, 11, Victoria Street, S.W., electrical engineer; and E. A. S. Daniell, 82, Marlborough Mansions, West Hampstead, N.W., electrical engineer. No initial public issue. Registered without articles of association.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Freshwater and Totland (I.W.) Electricity Supply Co., Ltd. (61,069).—This company's annual return, made up to September 13th, 1902, was filed on May 12th, 1903, when nine shares had been taken up out of a nominal capital of £15,000, in 15,000 shares of £1 each. Nothing has been called up. Mortgages and charges, *nil*.

Europe and Azores Telegraph Co., Ltd. (39,452).—This company's annual return was filed on February 13th, when 17,846 shares had been taken up out of a nominal capital of £200,000, divided into 20,000 shares of £10 each. £10 per share has been called up on 12,278 shares, resulting in the receipt of £122,780. 5,568 shares are considered as fully paid. No mortgages or charges.

Marconi's Wireless Telegraph Co., Ltd. (53,403).—This company's annual return was filed on April 23rd, when 157,216 shares had been taken up out of a nominal capital of £200,000 in 200,000 shares of £1 each. £1 per share had been called up on 97,216 shares, resulting in the receipt of £97,216. 60,000 shares are considered as fully paid. No mortgages or charges. (The capital has, since making up above return, been increased to £300,000 in £1 shares.)

Lymington Electric Light and Power Co., Ltd. (57,985).—This company's annual return was filed on May 2nd, when 1,710 shares had been taken up out of a nominal capital of £10,000 in 2,000 shares of £5 each. £5 per share has been called up, resulting in the receipt of £8,495. £55 remains in arrears. Mortgages and charges, £10,000.

County of London and Brush Provincial Electric Lighting Co., Ltd (34,320).—A trust deed dated May 12th, 1903, to secure £250,000 second debenture stock (with power to issue further stock making *pari passu* up to £400,000) has been registered. Property charged: The company's assets, present and future, as a floating security, subject to trust deed securing first debenture stock and such of the £400,000 debentures issued pursuant thereto as may be outstanding. Trustees: The Electric and General Investment Co., Ltd., 1—2, Great Winchester Street, E.C.,

London and Provincial Electric Construction Co., Ltd. (69,916).—£2,050 debentures dated May 5th, 1903, charged on the company's undertaking and property, including uncalled capital, subject to other charges not exceeding £950, have been registered. Holders: E. Middleton, 17, Victoria Street, S.W.; W. H. Halford, 32, Cornhill, E.C., and H. G. Gwinner, Union Court, Old Broad Street, E.C.

Notting Hill Electric Lighting Co., Ltd. (25,921).—£55,000 debentures, created by resolutions of May 25th, 1897, and February 17th, 1903, have been registered. Property charged: The whole of the company's undertaking and property. Trustees: Sir W. Crookes, Kt., 7, Kensington Park Gardens, W.; and R. B. Martin, M.P., 11, Hill Street, Mayfair. Date of trust deed: June 17th, 1897; of supplemental deed: June 30th, 1902.

New Century Arc Light Co, Ltd. (67,849).—Issue on May 8th of a second debenture for £3,000, part of a series created April 24th, 1903, to secure £5,000, charged as a second and floating security on the company's undertaking and property, present and future, including uncalled capital. No previous issue of same series. A postponing deed dated May 8th, 1903, prolonging until April 1st, 1904, the effect of a debenture dated February 7th, 1902, in favour of J. M. Bush, securing £2,000, a bonus of £500 and interest, has also been registered.

Woking Electric Supply Co., Ltd. (46,175).—Issue on May 9th of £200, on May 11th of £150, and on May 16th of £1,250 debentures, part of a series created November 2nd, 1899, to secure £35,000 charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £20,500.

Royce, Ltd. (Electrical Engineers, Manchester) (63,871).—Issue on May 14th of £9,500 debentures and on May 19th of £1,900 debentures, part of a series created March 27th, 1903, to secure £25,000. Property charged, the company's undertaking and property, present and future, except uncalled capital; trustees, Law Guarantee and Trust Society, Ltd., 49, Chancery Lane, W.C. No previous issue of same series.

Bright's Light and Power, Ltd. (58,290).—A third debenture, dated May 12th, 1903, securing £2,000 charged on the company's concessions, freehold and leasehold property, works and plant, in England and elsewhere, and its uncalled capital, has been registered. Holder, C. Owles, 16-17, Russell Street, Covent Garden.

Wycombe (Borough) Electric Light and Power Co., Ltd. (58,189).—Issue, on July 25th, 1902, of £10,000 debentures, part of series covered by trust deed of April 27th, 1899, and supplemental trust deed of July 16th, 1902, to secure £30,000. Property charged: The company's lands, buildings, plant, undertaking and property. Trustees: W. B. Hopkins, Clun House, Surrey Street, Strand; and F. E. Gripper, Broad Sanctuary Chambers, Westminster. Registered May 29th, 1903. Previously issued of same series: £15,000. Amount issued same date and previously registered: £5,000.

Telephone Co. of Egypt, Ltd. (17,824).—Issue, on May 20th, of £2,500 mortgage debentures, part of a series created December 8th, 1898, to secure £20,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series: £8,000.

Bromley (Kent) Electric Light and Power Co., Ltd. (54,197).—This company's annual return was filed on May 8th, when the entire capital of £50,000, divided into 10,000 shares of £5 each, had been taken up and paid in full. No mortgages or charges.

Cuba Submarine Telegraph Co., Ltd. (4,710).—This company's annual return was filed on May 20th, when the entire capital of £220,000, divided into 16,000 ordinary and 6,000 preference shares of £10 each had been taken up and paid in full. No mortgages or charges.

Indo-European Telegraph Co., Ltd. (73,514).—This company's annual return was filed on May 20th, when 17,000 shares had been taken up out of a nominal capital of £450,000 in 18,000 shares of £25 each. £25 has been called up on each share, resulting in the receipt of £425,000. No mortgages or charges.

ELECTRICITY SUPPLY ACCOUNTS.

Metropolitan Electric Supply Co. and Bradford Municipal Electric Supply.

We give this week an analysis of the returns of the Metropolitan Supply Co. and the Bradford municipal supply, in parallel columns.

Both undertakings occupy leading positions in their respective spheres, the former having started operations in 1888 and the latter in 1889.

Their similarity may, however, be said to end here, and the varied results obtained under the different conditions existing in the two cases are clearly shown by comparison.

The affairs of the Metropolitan Co. have been frequently before the public during the past year, both in connection with the transfer of the Marylebone area (including the Manchester Square and Rathbone Place generating stations) and in respect of the arbitration with the L.C.C. over the Sardinia Street works. During the year the company has added some 80,000 lamps and earned an increased profit of nearly £18,000. The supply embraces a large proportion of private lighting, some public lighting and motors, the increased output being obtained from the Willesden power station.

The Bradford Corporation supply has practically doubled itself during the past year, owing to the acquisition of a large traction load. The lamp connections have increased by 33,000, and the motor load by nearly 1,000 H.P. The department runs three stations, one at Bolton Road and two at Valley Road; the most recent one, to contain ultimately 20,000 H.P., being in process of extension to meet the growing demands of the area.

The following particulars of the two undertakings are of interest:—

		Metropolitan E. S. Co.	Bradford Municipal Supply
Number of units sold	Private lighting ...	12,406,012	1,910,871
	Public lighting ...	68,612	54,116
	Motive power ...	—	1,900,034
	Tramways	—	5,259,202
Total		12,474,624	9,124,223
Public lamps		—	51 arcs
Motors		—	913 = 4,398 H.P.
Gross revenue per unit sold ...		5·06d.	1·87d.
Works cost per unit sold		2·94d.	·85d.

The northern undertaking, while obtaining a small average revenue per unit, owing to the large proportion of power and traction supply, has the corresponding advantages of good load factor and cheap fuel. The supply is on the L.T. continuous, three-wire system. The Metropolitan Co. generates alternating current, transforming up and down and converting at sub-stations, for distribution on both L.T. alternating and L.T. three-wire continuous networks, and the works costs are probably higher than otherwise, owing to the system adopted and the number of small units which this company has in its older stations. The prices charged are—Metropolitan Supply Co., private lighting, 6d. to 4d. per unit; power, 3d. to 2d.; public arc lamps, £30 per annum. The Bradford Corporation charged for private lighting 4½d. per unit with discount, and free lamp supply; power, 1d. and 2d. per unit; tramways, 1d. per unit; public arcs about £12 per annum.

Mr. J. S. Highfield is the engineer-in-chief of the Metropolitan Co., and Mr. R. A. Chattock, the city electrical engineer to Bradford.

General Statement.

	Met. Elec. Supply Co.	Bradford Municipal Supply
For year ending December 31st—	1902.	1902.
Total capital expended	£1,846,448	£423,926
Number of units sold	12,474,624	9,124,223
Equiv. 8-C.P. lamps connected	723,000	239,509
Max. load in KW.	11,948	4,977
Revenue Account. Gross revenue	£261,073	£70,917
" expenditure	£152,289	£32,856
" profits	£108,784	£38,561
Average price obtained per unit.. ..	4·84d.	1·75d.

Revenue Statement.

	Gross.	Per unit.	Gross.	Per unit
By sale of energy	£252,304	4·84d.	£66,247	1·75d.
Rental of meters, &c.	8,332	·16d.	1,575	·04d.
Rental and sales of motors, arcs and fittings	—	—	3,094	·08d.
Property, rents receivable..	387	·06d.	—	—
Gross revenue	£261,073	5·06d.	£70,916	1·87d.

Working Expenses.

	Gross.	Per unit.	Gross.	Per unit
Coal	£68,562	1·32d.	£10,005	·26d.
Oil, waste, water and engine-room stores	7,034	·14d.	2,083	·05d.
Salaries and wages incurred in generation and distribution	18,177	·35d.	3,698	·10d.
Repairs and maintenance of buildings, plant, mains, and other apparatus on consumers' premises	26,390	·51d.	4,561	·12d.
Works and distribution costs ..	£120,193	2·32d.	20,342	·53d.
Rents, rates and taxes	12,450	·24d.	3,223	·09d.
Management expenses including salaries of engineer, secretary and clerical staff, and directors' fees, &c.	12,690	·24d.	1,881	·05d.
General establishment charges, printing, stationery, law, insurance, &c.	6,955	·14d.	6,930	·18d.
Total costs	£152,288	2·94d.	£32,356	·85d.

Financially the operations of the Metropolitan Co. resulted in a gross profit of £108,784, from which £10,000 was contributed to the depreciation and reserve fund (now standing at £98,447), and after paying interest and dividends, a balance of £1,373 was carried forward.

PROFIT STATEMENT.

Year ending December 31st—	1902.
To interest and dividends	£101,697
Balance carried forward	1,373
To depreciation and reserve fund...	10,000
Balance from last account, discounts, interest, &c.	— 4,286
Gross profits for year	£108,784

The Bradford undertaking realised a gross profit of £38,561, and after meeting financial charges and transferring £8,436 to the depreciation fund, a balance of £8,688 is carried forward.

PROFIT STATEMENT.

Year ending December 31st—	1902.
To interest on loans	£13,195
To sinking fund	15,143
Sundries	1,115
To depreciation fund	8,436
Balance from last account	— 8,688
„ carried forward	9,360
Gross profit	£38,561

CITY NOTES.

Prospectus.

MESSRS. ALLEY & MACLELLAN, LTD., the well-known engineers of Sentinel Works, Polmadie, Glasgow, have this week been before the public with an issue of £65,000—5½ per cent. cumulative preference capital in £1 shares. The vendors (Alley & MacLellan) are to take 50,000 of the ordinary shares (£1) in part payment of the purchase price for their undertaking, and 10,000 will be subscribed and paid for in cash at par by the vendors and their friends. The total nominal capital is £130,000. The average annual profit for the past seven years has been £14,676. The preference dividend will require £3,575, the balance being available for depreciation, reserve, directors' fees, and ordinary dividend.

Brighton and Rottingdean Seashore Railway Co.

AN ordinary meeting of the above company has been held, at which the Chairman stated that an Act had been obtained enabling the company to substitute an overhead tramway on piles for the tramway under water. The plans had been passed by the Board of Trade, and the company was waiting until the necessary capital had been obtained before beginning the construction of the line. It was estimated to cost £20,000, and about £6,000 for the new cars and electrical equipment.

Stock Exchange Notices.—The Committee has been asked to appoint a special settling day in—British Electric Transformer Co. (1903), Ltd.—30,390 6 per cent. cumulative preference shares of £1 each, 7s paid, Nos. 1 to 30,390, and 9,114 ordinary shares of £1 each, 7s. paid, Nos. 110,001 to 119,114; and to allow the following to be quoted in the Official List:—Primitiva Gas and Electric Lighting Co. of Buenos Ayres, Ltd.—Further issue of £25,000 4 per cent. first debentures of £100 each, Nos. 5,251 to 5,500. The Committee has also appointed a special settling day as under:—Thursday, June 18th—British Columbia Electric Railway Co., Ltd.—£175,000 4½ per cent. Vancouver Power debentures of £100 each, Nos. 1 to 1,750; and has ordered the undermentioned securities to be quoted in the Official List:—British Columbia Electric Railway Co., Ltd.—£175,000 4½ per cent. Vancouver Power debentures of £100 each, Nos. 1 to 750; Edmundson's Electricity Corporation, Ltd.—Further issue of £60,000 4½ per cent. first mortgage debenture stock (redeemable).

Blackpool Electric Tramways (south), Ltd.—An extraordinary general meeting is to be held at Blackpool on June 17th, to pass a series of resolutions with reference to the acquisition of shares in the Blackpool, St. Anne's and Lytham Tramways Co.

India-Rubber, Gutta-Percha and Telegraph Works Co.—The half-yearly meeting will be held at 106, Cannon Street, E.C., on June 16th, to sanction the payment of an interim dividend of 2½ per cent., or 5s. per share.

Provincial Tramways Co., Ltd.—The directors have resolved to pay an interim dividend of 3s. per share.

Metropolitan Electric Supply Co., Ltd.—Allotment letters have been posted to present holders of ordinary shares in the issue of 100,000 £5 4½ per cent. cumulative preference shares.

STOCKS AND SHARES.

Wednesday Evening.

SOMETHING akin to a semi-panic has seized the Stock Exchange markets in its violent grip during the past few days, and the tremendous fall of values in American Rails and African mining shares did not confine its influence to the two departments mostly affected. Speculators with heavy differences to face on open accounts have had to sell stock in other markets which they held for investment purposes, and the raising of the Berlin Bank Rate added a new item of unrest in the more sober sections of the Stock Exchange. Although most of the influences now at work are of a temporary character, the slump will probably have an effect of time-reaching importance, and it may be weeks, if not months, before the freshly-aroused feeling of suspicion is again lulled.

There are, however, no serious falls to chronicle in the prices of stocks and shares connected with the electrical markets. Only in the National Telephone issues is there any pronounced weakening. The Deferred stock has fallen 4½ points, less on the general flatness round the House than on the very particular reasons adduced by the statement of the Government in the House of Commons the other night. The Preferred stock has also shed a point; but the other varieties are unchanged, and having regard to the rapid rise that has taken place in both Deferred and Preferred, the reaction will, perhaps, be considered with equanimity by the stockholders.

A good deal of business is being done in the various new issues that have recently appeared. Edmundson's new shares are ⅛ to ¼ premium, and can be sold at the middle price. The investment, however, is too fine a one for shareholders to sell their rights, and the latter should be taken up. The fall of ¼ in the old Ordinary is consequent upon realisations by those who are desirous of applying for the new shares with the money.

Westinghouse New Preference command no premium from the stags' point of view, being quoted at par to ⅛ premium only. This issue has also lowered the price of the existing shares, which are now about 5⅞, the Debenture stock standing at 103. At 7 the Ordinary are somewhat easier, too, the placing of an additional half a million of capital in front of them not, of course, tending to their immediate advantage. The Metropolitan Electric Supply Co. placed its latest offer of Preference shares in the hands of its proprietors on Wednesday, and the nominal price at the time of writing is $\frac{1}{16}$ to $\frac{3}{16}$ premium.

Charing Cross Debenture stock has hardened a point, and in South Londons a little investment buying sufficed to raise the price ¼, Westminster Preference improving to the same extent. The rise in City of London Ordinary is maintained, and Metropolitan Ordinary are harder at 18 buyers, despite the appearance of the new issue.

Emphatic flatness in the steam railway stocks finds a faint reflection in a drop of 1 per cent. in Central London Ordinary; otherwise this section remains without alteration. The Underground stocks, however, have suffered more sharply; Districts are down to 37½, and Metropolitan Consolidated to 88½. A fresh outbreak of Light Railway activity in Dorsetshire and in the North of Scotland has produced no effect so far, but both the schemes now being advertised are, as yet, in their infancy.

Buenos Ayres and Belgrano shares continue active in the Tramway list, the Ordinary being 2⅞, the First Preference 5½, and the Second Preference 5. A further fractional advance has been scored by London United Preference, in which business is being done at 12. British Columbia Electric Railway Preferred Ordinary stock commands about 92 per cent., and the Deferred stands at a trifle over 70, the Preference shares being 10¼. It may be mentioned in passing that London General Omnibus stock is better at 97½, possibly upon the introduction of the new motor 'buses by this company.

In the Telegraph market, Submarine Cables Trust have fallen along with everything else American. The English group maintain their ground with a certain amount of fortitude. Globe Telegraph and Trust Ordinary are ¼ easier, holders having received the dividend, and some of them being therefore willing to sell now they have got their interest. India-Rubber shares are down ½ despite the dividend, and it is stated that the price of the commodity shows an unmistakable tendency to rise. British Insulated Debenture stock, rarely dealt in as a rule, have found a few supporters, and at 104½ the price is 1 per cent. higher.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900	1901.	1902.	Closing Quotations June 3rd.	Closing Quotations June 10th.	Business done week ended June 10th, 1903. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2½— 3½	2½— 3½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3½%	6½.	60/6	47 — 50	47 — 50	..	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	89 — 91	89 — 91	90½	90
3,105,580	Do. do. do. Deferred	Stock	5s. %	2s.	1/-	8 — 8½	8 — 8½	..	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	..	4⅜ — 5⅛	4⅜ — 5⅛	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	155 —155	155 —155	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	89 — 92	89 — 92	91½	90½
16,000	Cuba Telegraph	10	4½%	4 %	6½%	6¼ — 7½	6¼ — 7½	..	..
6,000	Do. 10 % Pref.	10	..	..	..	15 — 16	15 — 16	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2½ — 3½	2½ — 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	98 —102	..	..	..
60,710£	Direct United States Cable	20	8½%	8½%	..	9 — 10	9 — 10	9¼	9¼
92,800£	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,900, Red.	100	..	..	..	99 —102	99 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	118 —123	118 —123	123⅜	119⅜
1,955,565	Do. 5½ % Pref. Stock	100	..	..	..	82 — 85	82 — 85	84½	84
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	104 —107	104 —107	105½	104½
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	10½ — 11½	10½ — 11½	11⅛	10⅝
820,000£	Do. 4 % Deb. Stock	Stock	..	..	..	105 —108	105 —108	106½	..
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	101 —104 %	99 —102	..	..
180,227	Globe Telegraph and Trust	10	5½%	5½%	..	8½ — 9	8½ — 8⅝	8⅝	..
180,042	Do. do. 6 % Pref.	10	..	..	..	11½ — 12½	11½ — 12½	11⅝	11⅜
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	12½%	22 — 24	22 — 24	23½	22½
66,300£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10%	36 — 40	36 — 40	..	..
100,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	..	..	..	100 —104	100 —104	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	5 %	6 %	102 —104	101 —103	103½	101
1,966,667	Do. do. Def. Stock	100	..	..	4½%	88 — 90	83 — 86	87	83½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 13	12 — 13	12½	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅛ — 5⅝	5⅛ — 5⅝	5⅝	5⅛
2,000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	98 —100	98 —100	98⅝	98
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	102 —104	103 —105	102½	102⅛
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6 %	⅞— 1	⅞— 1	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	5 %	..	6½ — 7½	6½ — 7½	..	..
3,308	Submarine Cables Trust	Cert.	..	..	..	102 —112 xd	101 —109	109½	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5½ — 6	5½ — 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4½ — 5½	4½ — 5½	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	105 —108	105 —108	..	..
15,609	West African Telegraph, Shares	10	..	..	..	3 — 4	3 — 4	..	..
30,008	West Coast of America, Nos. 1 to 30,000 and 53,001 to 53,008	2½	..	..	..	0 — ¼	0 — ¼	..	..
150,000£	Do. do. 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	..	..	..	92 — 97	92 — 97	..	..
207,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	..	11 — 12	11 — 12	11½	11
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	101 —104	101 —104	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	96 — 99	96 — 99	..	..
88,321	West India and Panama Telegraph	10	1½%	..	..	⅛— ¼	⅛— ¼	..	..
84,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6½	6 — 6½	6½	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	3¼— 4½	3¼— 4½	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,600	100	..	..	..	99 —102	99 —102	101	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	3 — 4	3 — 4	..	..
800,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	73 — 78	73 — 78	..	..
100,000	British Electric Traction	10	9 %	9 %	..	14 — 14½	14 — 14½	14⅛	14½
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	12 — 12½	12 — 12½	12 7/16	12⅛
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	122 —125	122 —125	124⅛	123½
100,000	British Insulated and Helsby Cables	5	15 %	10 %	10 %	6¾— 7¼	6¾— 7¼	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5¾— 6	5¾— 6	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —106	103 —107	106½	104½
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	⅞— 1	⅞— 1	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	15/6 to 16/6	15/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	Nil	1— 1¼	1— 1¼	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %	6 %	1¼— 1½	1¼— 1½	1½	1⅞
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	89 — 94	89 — 94	..	..
85,000	Callender's Cable Construction shares	5	15 %	20 %	15 %	12½— 13½	12½— 13½	13½	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5½— 6	5½— 6	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	108 —112	108 —112	..	..
1,660,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	106 —109	105 —108	..	..
494,098	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	108 —106	103 —106	104	..
494,998	Do. do. Def. do.	Stock	..	4 %	4 %	108 —111	108 —111	110	..
1,330,000	City and South London Railway	Stock	1½%	2 %	3½%	71 — 73	71 — 73	72½	71
85,000	Crompton & Co., Nos. 1 to 85,000	2	8 %	7½%	..	2 — 2½	2 — 2½	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	102 —106	102 —106	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	2½%	Nil	..	1¼ — 2	1¼ — 2	..	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	73 — 77	73 — 77	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	75 — 80	75 — 80	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1½ — 2	1½ — 2	..	..
31,250	Do. do. 7 % Cum. Pref., 1 to 31,250	2	..	..	..	2¼ — 2⅝	2¼ — 2	2 5/16	..
32,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	100 —103	100 —103	101	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9½ — 10½	9½ — 10½	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	99 —102	99 —102	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	15 — 16	15 — 16	15⅝	..
35,000	Do. do. 4½ % Pref.	5	4½%	..	..	5 — 5½	5 — 5½	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111	107 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	19 — 20	18½ — 19½	..	..
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	9½%	11%	11%	5¾— 6	5¾— 6	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10½ — 11	10½ — 11	..	..
37,350	Telegraph Construction and Maintenance	12	17½%	20 %	20 %	33 — 35	33 — 35	34	33
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1900	100	..	..	..	101 —104	101 —104	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3½%	99 —102	99 —102	100	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 1/- —2/-.
National Electric Free Wiring, 14/- —16/-.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 14½—14¾.
Do. do. Pref (£10 pd.), 10—10½.

Bank rate of discount 3½ per cent. (May 21st, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations June 3rd.	Closing Quotations June 10th.	Business done week ended June 10th, 1903. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord.	£ 1	..	..	..	⅜ — ½	⅜ — ½	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	..	..	..	118 —121	118 —121	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000	5	6 %	8 %	8 %	10¼ — 11	10¼ — 11	..	..
20,000	Do. do. 7 % Cum. Pref.	5	..	..	..	10⅞ — 10¾	10⅞ — 10¾	..	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	10 %	10 %	9 — 9¼	9 — 9¼	9¼	..
70,000	Do. do. do. 4½% Cum. Pref.	5	..	..	..	5⅛ — 6	5⅛ — 6	5⅛	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	..	..	..	4⅝ — 5⅛	4⅝ — 5⅛	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	105 —107	106 —108	..	..
44,486	*Chelsea Electricity Supply, Ord.	5	5½%	4 %	4½%	6 — 6¼	6 — 6¼	..	..
150,000£	Do. do. % Deb. Stock Red.	Stock	..	..	..	109 —112	109 —112	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	0 %	5 %	5 %	11½ — 12	11½ — 12¼	11⅛	11⅛
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	..	..	13 — 14	13 — 14	13⅛	13⅛
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	123 —128	123 —128	125	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	104 —107	104 —107	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4 %	8 — 9	8 — 9	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	..	..	..	12 — 13	12 — 13	12⅝	..
400,000£	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red	..	..	..	..	111 —114	111 —114	112¾	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	6⅞ — 7⅛	6⅞ — 7	6⅞	..
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6 — 6¼	6 — 6⅛	6⅛	6¼
140,000	Do. do. 4½% 1st Mort. Deb. Stock	100	..	..	..	107 —110	107 —110	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	12 %	10 %	10 %	11 — 12	11 — 12	..	..
90,000	Do. do. do. 4 % Debenture Stock	Stock	..	..	..	103 —106	103 —106	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	2⅜ — 2¾	2⅜ — 2¾	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5⅛ — 6	5⅛ — 6	..	..
250,000£	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	100 —103	100 —103	102½	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6 %	6¾%	7½%	17½ — 18¾	17½ — 18¾	18¾	17⅞
220,000£	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	110 —115	110 —115	..	..
250,000£	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	98 —101	98 —101	..	..
10,852	Notting Hill Electric Lighting	10	7 %	6 %	6 %	14 — 15	14 — 15	14½	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15½ — 16½	15½ — 16½	16	15⅞
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	8¾ — 9⅛	8¾ — 9⅛	..	..
150,000£	Do. do. do. 3½% Deb. Stock Red	100	..	..	..	99 —102	99 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	2½%	3 — 3¼	3 — 3¼	..	..
50,000£	Do. do. 4% Deb.	100	..	..	..	88 — 93	88 — 93	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	1½%	3¼ — 3⅜	3¼ — 4	3⅛	..
30,000	Urban Electric Supply, Ord.	5	..	..	..	5 — 5¼	5 — 5¼	..	..
30,000	Do. do. 5 % Cum. Pref.	5	..	..	..	5 — 5¼	5 — 5¼	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	10½%	12 %	12 — 13	12 — 13	13¼	12⅝
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6¼	6¼ — 6⅜	6⅞	6⅛

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, June 10th.

	CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
e	Acid, Hydrochloric	per cwt.	5/-	..
e	" Nitric	per cwt.	22/-	..
e	" Oxalic	per cwt.	32/-	..
e	" Sulphuric	per cwt.	5/6	..
e	Ammoniac, Sal	per cwt.	42/-	..
e	Ammonia, Muriate (crystal)	per ton	£33 10	..
e	" "	per ton	£30	..
e	Bleaching powder	per ton	£4 10	..
e	Bisulphide of Carbon	per ton	£15	..
e	Borax	per ton	£13	..
e	Benzole (90 %)	per gal.	7/-	..
e	" (50/90 %)	per gal.	5/6	..
e	Copper Sulphate	per ton	£21	..
e	Lead, Nitrate	per ton	£24	..
e	" White Sugar	per ton	£31	..
e	" Peroxide	per ton	£37 10	..
e	Methylated Spirit	per gal.	2/6	..
e	Naphtha, Solvent (90% at 160° C).	per gal.	5/6	..
e	Potash, Bichromate, in casks	per lb.	8d.	..
e	" Caustic (75/80%)	per ton	£24	..
e	" Bisulphate	per ton	£35	..
e	Shellac	per cwt.	127/-	2/- inc.
e	Sulphate of Magnesia	per ton	£4 10	..
e	Sulphur, Sublimed Flowers	per ton	£6 5	..
e	" Recovered	per ton	£5 10	..
e	" Lump	per ton	£5	..
e	Soda, Caustic (white 70 %)	per ton	£10 15	..
e	" Crystals	per ton	£8	..
e	" Bichromate, casks	per lb.	2½d.	..
	METALS, &c.			
b	Aluminium Ingots, in ton lots	per ton	£130	..
b	" Wire, in ton lots	per ton	£168	..
b	" Sheet, in ton lots	per ton	£166	..
p	Babbitt's metal ingots	per ton	£43 to £145	..
c	Brass (rolled metal 9" to 19") basis	per lb.	7¼d.	..
c	" Tube (brazed)	per lb.	9d.	¼d. dec.
c	" (solid drawn)	per lb.	7¾d.	¼d. dec.
c	" Wire, basis	per lb.	7¾d.	..
c	Copper Tubes (brazed)	per lb.	9½d.	¼d. dec.
c	" " (solid drawn)	per lb.	9¾d.	¼d. dec.
g	Copper Bars (best selected	per ton	£75	..

	METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g	Copper Sheet	per ton	£75	..
g	" Rod	per ton	£75	..
c	" (Electrolytic) Bars	per ton	£68	£2 dec.
c	" " Sheets	per ton	£79	£2 dec.
c	" " Rod	per ton	£70	30s. dec.
c	" " H.C. Wire	per lb.	8¼d.	¼d. dec.
f	Ebonite Rod	per lb.	8/-	..
f	" Sheet	per lb.	5/-	..
a	German Silver Wire	per lb.	1/6	..
h	Gutta-percha fine	per lb.	8/-	..
h	India-rubber, Para fine	per lb.	3/10 to 3/10½	..
i	Iron, Charcoal Sheets	per ton	£18	..
i	" Pig (Cleveland warrants)	per ton	45/9	1d. inc.
i	" Forgings, according to size	per ton	From £11	..
i	" Scrap, heavy	per ton	£7/6 to £9/-	..
i	" Wire, galvanised No. 8	per ton	£9 15	..
g	Lead, English Ingot	per ton	£11 12 6 to £11 15	2/6 dec.
g	" " Sheet	per ton	£14 10	..
m	Manganin Wire No. 28	per lb.	9/-	..
g	Mercury	per bot.	£8 12 6	..
d	Mica (in original cases) small	per lb.	3d. to 1s.	..
d	" " medium	per lb.	2s. to 3/3	..
d	" " large	per lb.	3/6 to 7/3	..
p	Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p	" rolled bars & rods	per lb.	1/1 to 1/4	..
p	" " strip & sheet	per lb.	From 1/2	..
o	Platinum	per oz.	£4	..
p	Silicium Bronze Wire	per lb.	10d. to 1/-	..
i	Stee., Magnet, acc'd'g to deso'p'n	per ton	£58	..
i	" " in bars	per ton	£15 to £40	..
g	Tin, Block	per ton	£127 to £128	£3 dec.
g	" Foil	per lb.	1/6½	..
n	" Wire, Nos. 1 to 16	per lb.	1/7½	½d. dec.
p	White Anti-friction Metals—			
	"White Ant" brand	per ton	£42 to £55	..
j	Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7¼d.	..
j	" 6 les. Flax	per lb.	5¾d.	..
j	" 3 ply 10 lbs. Russian	per lb.	4¼d.	..
j	" 10 lbs. Russian, single	per lb.	4¼d.	..
j	" 180 lbs. Jute rove	per ton	£11	..
k	Zinc, Sh't (Vieille Montagne bnd.)	per ton	£24 15	..

Quotations supplied by Messrs.:—a G. Boor & Co.; b The British Aluminium Co., Ltd.; c Thos. Bolton & Sons., Ltd.; d F. Wiggins & Sons.; e Frederick Smith & Co.; f India-Rubber, G.P. and Teleg. Works Co., Ltd.; g James & Shakspeare; h Edward Toll & Co.; i Bolling & Lowe; j W. H. Hindley & Co.; k Morris Ashby, Ltd.; m W. T. Glover & Co., Ltd.; n P. Ormiston & Sons; o Johnson, Matthey & Co., Ltd.; p The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

	Locality.	Week ending	Receipts for the week. £	£*	Total to date. £	£*	Miles open.	*
	Aberdeen	June 6	1,388	+274	—	—	—	—
	Birmingham	" 6	6,214	+938	114,971	+ 6,470	—	—
	Bournemouth	" 3	1,409	—	—	—	—	—
	Blackburn	" 5	1,308	+ 279	9,176	+ 895	12½	+1½
	Blackpool	" 4	1,811	+1151	6,726	+ 415	—	—
	Blackpool and Fleetwood	" 6	2,068	−1587	7,997	+ 623	7½	—
	Bolton	" 7	2,470	+854	18,645	+ 3,968	25	—
	Bradford	May 24	3,871	−197	27,589	+ 2,311	39	+2
	Brighton	June 7	1,944	+417	5,186	—	6½	—
	Bristol	" 5	8,008	+3330	—	—	28	—
	Burnley	" 6	970	+148	—	—	—	—
British Elec. Trac. Co.	Barnsley District	May 29	192	—	3,604	—	—	—
	Devonport	" 29	458	— 97	8,675	+ 123	5	—
	Dudley—Stourbridge	" 29	681	+115	15,711	+ 1,041	12½	—
	Gateshead	" 29	704	+157	17,504	+ 3,374	10½	+ ½
	Gravesend—Northfleet	" 29	254	—	4,166	—	3½	—
	Greenock—Pt. Glasgow	" 29	725	+200	9,975	+ 923	7½	—
	Hartlepool	" 29	276	— 0	4,480	+ 360	6½	+2
	Kidderminster	" 29	104	+ 12	2,286	+ 18	4½	—
	Morthyr	" 29	207	— 6	3,940	— 254	8	—
	Middleton	" 29	417	— 53	5,782	+ 62	6½	—
	Oldham—Ashton	" 29	645	+ 11	11,555	+ 1,079	8	—
	Peterborough	" 29	153	—	2,518	—	—	—
	Poole	" 29	312	+ 53	5,484	+ 901	8½	—
	Potteries	" 29	1,651	+212	32,513	+ 2,988	29½	—
	Rotherham	" 29	139	+ 63	1,460	+ 613	—	—
	Sheerness	" 27	80	—	679	—	—	—
	Southport	" 29	313	— 53	5,347	+ 1,181	5½	—

* Compared with the corresponding period of 1902.

	Locality.	Week ending	Receipts for the week. £	£*	Total to date. £	£*	Miles open. *
B.E.T. Co.	South Staffordshire	May 29	962	+148	16,446	+ 288	21½ −½
	Swansea	" 29	518	+ 41	9,794	+ 694	5½ —
	Taunton	" 29	56	— 6	1,135	— 98	1½ +½
	Tynemouth	" 29	342	+ 80	5,090	+ 480	2½ —
	Weston-super-Mare	" 27	99	— 29	974	— 265	2½ +½
	Wolverhampton Dist.	" 29	296	+257	7,722	+ 4,270	10½ +8
	Wrexham	" 29	179	—	1,168	—	— —
	Yorks. Woollen Dist.	" 29	401	—	3,538	—	6 —
	Cardiff	June 6	2,734	+1318	18,451	+ 8,594	— —
	Dover	" 6	271	+ 12	4,359	+ 84	8 —
	Dublin	" 5	6,057	+1602	101,366	+ 5,565	46 —
	East Ham	" 6	997	+546	6,531	+ 2,256	5 + ½
	Glasgow	" 6	15,376	+3194	15,376	+ 3,194	55 +15
	Hull	" 6	2,094	+828	17,927	+ 1,712	— —
	Isle of Thanet	" 6	1,011	+388	8,545	— 441	— —
	Leeds	" 6	7,681	+1777	56,767	+ 5,056	— —
	Liverpool	May 30	10,862	+1116	210,507	+11,555	101 +6
	Manchester	June 6	16,022	+10235	—	—	110 +35
	Newcastle	" 6	3,831	+1158	—	—	17 —
	Portsmouth	" 6	2,488	+898	—	—	29 —
	Salford	May 25	3,610	— 38	25,990	+ 6,496	— —
	Southampton	June 4	1,367	+345	—	—	— —
	Sunderland	" 8	1,809	+669	11,649	+ 890	20 —
	Central London Railway	" 6	7,327	— 8	16,040	+ 6,219	6 —
	Chatham & District Co.	" 4	764	—	10,177	—	8½ —
	City and S. London Ry.	" 7	2,270	−495	71,098	+ 2,603	6½ —
	Dublin and Lucan Elwy.	" 7	181	+ 62	2,269	+ 60	— —
	Liverpool Overhead Ry.	" 7	2,006	+500	26,387	+ 3,468	6½ —

WIRELESS TELEGRAPHY IN THE UNITED STATES.

By E. GUARINI.

(*Concluded from page* 987.)

One form in which the De Forest receiver is carried out (fig. 18) consists in an anti-coherer connected, on the one hand, to earth, and on the other, to the antenna, and put in circuit with a battery and the winding of a telephone. In its normal state, the current of the battery passes through the winding of the telephone, and the vibrating disc of the latter is attracted. As soon as, under the influence of the variable electro-magnetic field produced by the transmitter, a current is induced in the antenna and passes to the ground

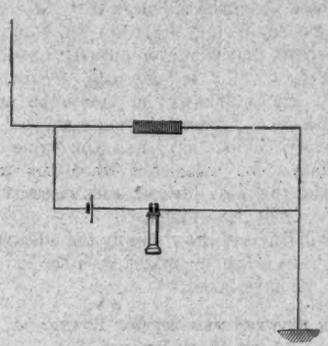


Fig. 18.

through the anti-coherer, the resistance of the latter is considerably increased. Then, in consequence of this increased resistance, the disc of the telephone is suddenly relaxed, as if the circuit had been cut, giving out a sharp sound. As soon as the wave ceases, the closing of the circuit is produced. In practice we must look at it as if the telephone had been placed in circuit with an intermittent current closed and opened by an automatic switch, viz., the distant wave. A dot imparts to the telephone a sound of short duration; a dash, a more prolonged sound.

Another form of the De Forest receiver consists (fig. 19) in introducing into the circuit of the battery two anti-coherers instead of one. This arrangement enables a higher electromotive force to be used, although the critical pressure of the anti-coherers must not be exceeded; this critical pressure is equal to the sum of the critical pressures of the two anti-coherers. The circuit includes, besides, three inductance coils. The winding of the telephone, placed in circuit with a condenser, is put in shunt to a coil.

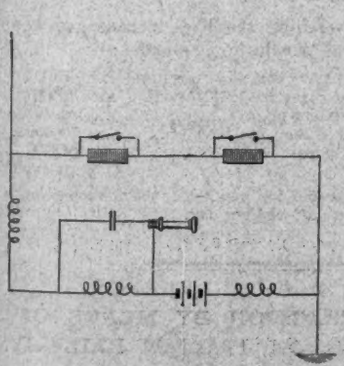


Fig. 19.

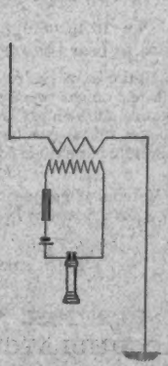


Fig. 20.

This system has three advantages:—

1. The impedance of the coils prevents the oscillations from reaching and weakening the battery.

2. In consequence of the supplementary resistance introduced into the circuit the current which is constantly passing through it is much weaker—which is not the case with the coherer.

3. The sound heard at the telephone is louder than in the other arrangement. In fact, when the anti-coherer is working, an extra breaking current is produced which charges the condenser after having passed through the winding of the telephone.

We may add that the keys shown enable the antenna, in case of storms, to be connected to earth without the current passing through the anti-coherers.

In a third form of construction, the antenna is connected to earth through the primary of an induction coil (fig. 20). The secondary of this coil contains in series with it, the anti-coherer, the battery, and the winding of the telephone. This arrangement serves a double purpose; to allow the silent atmospheric electricity to pass to earth without influencing the anti-coherer; and then to raise the pressure of the wave, which is advantageous to the working of the anti-coherer.

By this system the rate of transmission has been brought up to 30, 40, and 50 words per minute and even more. This speed is not astonishing if we consider that the transmitter is not burdened with an interrupter that has to be started, and that the receiver, besides the fact that it has not to overcome the inertia of the coherer, has no striker, relay or Morse receiver to start.

We will now examine briefly the conditions that a transmitter must fulfil in order to allow of a high speed of transmission. The receiver need not occupy our attention from this point of view, since it possesses all the necessary qualifications for a rapid apparatus. Leaving aside the starting of the interrupter, the slowness of the transmission is caused (1) by the time required for establishing the current in the primary of the transformer; (2) by the time taken up in charging the discharging circuit (oscillator, condenser, earth, antenna). To shorten this time as much as possible, and consequently, to make the speed of transmission as great as possible, we must have a low self-induction, and a low capacity in the primary of the transformer, and moreover, a low capacity and a very high pressure in the discharging circuit. Now, the De Forest transmitter seems eminently fitted to fulfil these conditions.

We find that Marconi, in his trans-Atlantic experiments, chose the same mode of obtaining comparatively rapid transmissions; in his apparatus also we find an alternator and a transformer instead of the Ruhmkorff coil; in his receiver a telephone without a local battery. Several stations are provided with the De Forest system. Of these the most important is that at Coney Island. It is provided with an antenna 210 ft. long and uses alternating current at 110 volts, which is transformed into 25,000 or 50,000 volts. It communicated in June, 1902, with the *Morro Castle*, which was provided with an antenna 60 ft. high, at a distance of 50 miles. In February the *Etruria* and the Jersey City station, the latter being fitted with a mast rising 30 ft. above the roof, communicated at a distance of 90 miles. Some time after the Staten Island station established communication at a distance of 70 miles with the *Deutschland* of the Hamburg-America Co. provided with Slaby-Arco instruments. Some very fine results were obtained also at the time of the last American military manœuvres between Fort Mansfield and the *Unique*. The fort was fitted with a mast 80 ft. high; the *Unique* with a mast 40 ft. high supporting an antenna 65 ft. high. The maximum distance of transmission was 50 to 60 miles, the maximum speed 40 words per minute, and the mean speed 20 words.

This is a brief description of this remarkable system. It has been announced several times that an action has been commenced between the De Forest Co. and the American Marconi Co. What it is that Marconi accuses De Forest of we do not exactly know. At any rate, we should look in vain, in the De Forest arrangements, for anything whatever belonging to Marconi.

If we consider the De Forest transmitter, we see that Marconi cannot claim the connection of the secondary of the transformer, on the one hand, with the earth, and, on the other hand, with the antenna. This arrangement is found in the Edison transmitter. Nor can he claim the connection of the secondary with the oscillator; Hertz had already done this. Moreover, the combination of the secondary of the coil with a simple oscillator (two balls) an earth connection and an antenna is public property, since M. Della Riccia, then Lieutenant of Engineers, proposed it

in the *Rivista di Artiglieria e Genio* (September, 1897). This was, it will be remembered, after the Spezzia experiments, in which Marconi used an oscillator with four balls (Righi). And, indeed, Mr. De Forest might—and with advantage, we think—abandon the earth connection. From the experiments described by the writer in the ELECTRICAL REVIEW of January 11th and 18th, 1901, it follows that when an oscillator is shunted by condensers and the antenna connected with the discharging circuit, the connection to earth has very few advantages. Better results are obtained without it. According to what M. Rochefort said a year ago, he found, and so did Lieut. Tissot, that the connection to earth is even disadvantageous under these conditions.

If we now pass on to the receiver, there is no doubt that the combination of an anti-coherer with a telephone belongs to De Forest. The connection of the detector on the one hand to the earth, and on the other to the antenna, cannot be claimed by Marconi, since the coherer is found in the Popoff systems (1898) and the telephone in the Edison system (1891). As to the induction coil which was, as we know, suggested in the first place by Lodge, what we have to notice is the connection of his primary to the earth. That arrangement cannot be claimed by Marconi, but only one in which a coherer or *any other imperfect contact* is used.

In Tesla's system, which preceded Marconi's, we also find an antenna connected to earth through the primary of an induction coil, the secondary containing *the receivers*, lamps, motors, &c.

But it is to be observed that the anti-coherer is not an imperfect contact; it is, on the contrary, so perfect that in its normal state it lets the current pass as if it did not exist. Thus the De Forest instruments do not come under the application of Marconi's claims. Moreover we shall see that the arrangement in the secondary differs very much from Marconi's, as does also the arrangement very different from De Forest's indicated in our English patent No. 1,555, January 24th, 1900. Mr. De Forest puts everything in series. From what we have said, it is almost certain that the decision will be in favour of Mr. De Forest.

In conclusion, the writer may mention some unpublished information which has reached him from America: The De Forest Co. is making some machines of 150 KW. They will be sent to California, Honolulu, Manila and Hong Kong with a view to trans-Pacific communication. The company hopes within 18 months to establish trans-Pacific communication. It also hopes to establish a large number of coast stations on the Gulf of Mexico and in South America.

THE PROFITABLE APPLICATION OF BLAST FURNACE GAS FOR POWER PURPOSES.

BY HORACE ALLEN, C.E.

WHILE the engineering papers are giving so many instances of the application of blast furnace gas for driving gas engines, along with details of the different types of engines exploited by the various manufacturing firms, but little prominence is given to the saving in cost of fuel as compared with steam engines using coal.

The profitable application of blast furnace gas for power purposes requires, in the first place, an available supply of this gas. At most ironworks of importance, it is the case that the gas is at present utilised to about the fullest extent possible under existing arrangements. This being so, the question that occurs to one is as to the efficiency of the present ordinary methods of, first, preventing loss of gas through leakage and other causes; and, second, applying the gas for the development of power.

The answer as to whether reasonable care is taken to prevent loss of gas will mostly be a distinct negative, while, in regard to present applications, it will be shown that these are very inefficient, and require to be improved.

In regard to the efficiency of blast furnace gas when applied to a Babcock & Wilcox boiler, Mr. H. G. Scott * has made careful tests, and, allowing 20 lbs. of steam per I.H.P.-hr., found the combined efficiency of the engine and boiler to be 6·732 per cent.

For comparison, he also gives the figures he obtained from using the gas in a gas engine, when the efficiency was found to be 25·43 per cent.

The ratio of thermal efficiencies was in this case:—

Gas engine	... ...	1
Steam ,,	... ...	3·7

For the boiler, the gas had an initial temperature of 595° F., while for the gas engine it was cooled to 65° F.

The ratio given above may be taken as a minimum, for boilers much below the Babcock & Wilcox type in efficiency are generally employed, and for the test "every care was taken to ensure as perfect combustion as possible, an analysis of the flue gases yielding nearly 18 per cent. of CO_2 by volume, the flue temperature being 580° F.;" the conditions, therefore, were above the normal.

We shall be well within the mark if we take the net ratio between the gas engine and the steam boiler and engine as 1 to 4. This shows that whatever power is now developed by blast furnace gas at an ironworks can be increased by the application of gas engines to four times the amount, three times the total horse-power at present generated being available for profitable application; and the value of this extra power can readily be calculated when the fuel cost per I.H.P.-hr. under the most advantageous circumstances in the particular district is determined.

The following figures show plainly the advantage of blast furnace gas, even when compared with the low fuel cost for steam which we have taken:—

COMPARISON BETWEEN THE COST OF POWER, &C., FOR STEAM AND BLAST FURNACE GAS.

From experience with the Thwaite-Gardner system:—

Steam Power Station.

Capacity of station	3,000 KW.
Load factor ... ... Full load,	4,000 hours per year.
Total capital cost, exclusive of mains	£90,000
E.H.P.	4,020
Cost of fuel per unit	·20d.
Works cost per unit	·60d.
Cost of fuel per annum	£10,000

Blast Furnace Gas-Driven Station.

Capacity of station	3,000 KW.
Load factor ... ... Full load,	4,000 hours per year.
Total capital cost, exclusive of mains (taken same as steam installation)	£90,000
E.H.P.	4,020
I.H.P. at 80 per cent.	5,025
Cost of engines—Gas engines at £10 per I.H.P. (included in total capital)	£50,250
Cost of fuel per unit	·083d.
Works cost per unit	·517d.
Cost of fuel per annum—Blast furnace gas at ¼d. per 1,000 cub. ft.	£4,187 10s.
Saving effected in cost of fuel per annum	£5,812 10s.

Compared with ·2d. per unit, the equivalent value of blast furnace gas per 1,000 cub. ft. = 1·194d.

The iron company selling the blast furnace gas would have to bear the cost of purification, as under:—

Capital cost of gas treatment plant at £2 per I.H.P.	£10,050
Interest on gas treatment plant per 1,000 cub. ft. ...	·00067d.
Depreciation on gas treatment plant ,, ,, ...	·00067d.
Cost of labour (two men at 10d. per hour)	·00055d.
Revenue per annum for spare cleaned gas	£4,171 13s.
	41 % on capital.

Volume of gas per hour 502,500 cub. ft., or the volume given off by a furnace using 71 tons of coke per day.

ELECTRIC TRACTION BY MEANS OF ACCUMULATORS ON ITALIAN RAILWAYS.

ELECTRIC traction on the third-rail and sub-station system is mainly adapted for lines on which there is much traffic. As this is the exception on the greater portion of the railway system in Italy, the Italian Government and the authorities of the Meridional Railways decided to give the accumulator system a trial. This has now been in use for over a year, and the results are worthy of consideration. The cars each consist of a "body" having seating accommodation for 64 passengers (divided into two classes), and

* *Engineering*, May 22nd, 1903.

standing room for 26 others, a central portion being divided off to receive a certain amount of luggage. The body is mounted on two four-wheel bogies, one axle of each bogie being driven through spur gearing by a 50-H.P. electric motor; the two motors to each car are in series, and the gearing in the ratio of 1 to 6.

The cars each weigh 38 metric tons without batteries or passengers, four of the 38 tons representing the weight of the motors and other electrical appliances. They were built by Messrs. Diatto, of Turin, the electrical part of the work being carried out by Messrs. Ganz & Co., of Buda-Pesth. Westinghouse brakes are fitted to one axle—the non-driven one—of each of the bogies, these brakes being worked by a small electric pump located in the central compartment. The cars are fitted with controlling gear at each end; each controller comprises two cylinders, of which one is connected up so as to vary the grouping of the motors and the other that of the battery. The latter is carried under the car; it weighs about 3 metric tons, and comprises 266 cells, arranged in three groups of four boxes, or 12 boxes in all. In each ebonite cell there are 15 plates. The boxes are slid laterally, on wooden rollers, into position on the car. The wires from each of the three groups are connected up to a switchboard in the luggage compartment, so that in case of accident to any one of them, it may be cut out. A voltmeter, with switch, is provided for each of the groups. In the case of interruption of the circuit, the motor-man is notified of it by the reduction in speed; by means of a speaking tube he communicates with the conductor, who, from the voltmeters, can at once see which group is at fault, and put it out of circuit, the operation not taking more than two minutes, and without requiring the vehicle to be stopped, or the driver to leave his post. The 12 boxes of cells can be withdrawn by two men in 10 minutes; they are only entirely withdrawn when it is necessary to renew the plates—for re-charging and inspection purposes they are only partially withdrawn. A separate battery of 20 cells is provided for the lighting of the cars, which have, states the *Genie Civil*, been in use on the Bologna-Modena (23 miles) and the Bologna-San Felice lines (26½ miles) since December, 1901. The maximum grade on the former is 5½ per cent., and on the latter 5 per cent.

Below we give a summary of the result obtained. During a total mileage of 11,785 miles, the cars had only to be hauled home on two occasions, owing to the running down of the batteries. At a speed of 35 kilometres (22 miles) per hour, the car resistance was found to be 4·33 kgm. (9½ lbs.) per metric ton, and the energy consumption 12½ watt-hours, at the motor terminals.

Each charge of the battery corresponds to 4,410 kilometre-tons (car-weight complete, 52½ tons; distance on one charge, 84 kilometres), and requires on the average 104 KW.-hours. The consumption of energy at the power station is $\frac{104.000}{4,410}$ = 23·6 watt-hours per ton-kilometre. The energy efficiency of the battery on the Bologna-Modena line has been found to be 57 per cent; the normal speed on this line is 28 miles per hour, and the maximum 33¾ miles. With regard to the life of the batteries, it has been found that the positive plates last for an average of 6,875 miles, and the negatives for double that distance. The cost of plates works out at 24 centimes per kilometre, or ·00456 centime per ton-kilometre. The inspection, electrolyte and repairs to the batteries cost during the first year 12 centimes per kilometre, or ·00228 per ton-kilometre. Taking the kilowatt-hour at 10 centimes (1d.), the cost of traction per metrical ton-kilometre works out at:—

Energy	·00236	centime
Renewal of plates...	·00456	"
Maintenance	·00228	"
Total	·00920	"

Bury (Lancs.) Tramways.—At the meeting of the T.C. on June 4th it was reported that the Corporation would provide and maintain the overhead equipment of the lines in Radcliffe which had been leased from the U.D.C. for 30 years. Bury will take energy from Radcliffe electricity works at 1¼d. per unit for less than 30,000 units, and 1⅛d. for more.

ELECTRICITY SUPPLY IN LONDON.

(Concluded from page 985.)

Although useful to analyse the commercial results of the electricity supply undertakings within the county of London, the real question for the public is whether trading by municipalities in competition with private enterprise is politically sound, and especially in an industry requiring technical knowledge and subject to rapid changes during development.

Parliament has recognised the right of municipalities to trade in the supply of electricity—and the Acts give them preferential rights to trade, as well as to exercise considerable control over working by companies—and it is in the direction of prohibition and limitation of this trading that the future action of the Legislature is needed.

The justification put forward by the Municipal Socialist in support of his views is that the public are better served and the community generally derive a profit, which is not the case when the business is carried on by ordinary traders.

Whether this were so or not, if municipal interference with trading is wrong in principle, it is not a sufficient defence to try and prove that it sometimes pays.

The great difficulty in comparing the trading results of one local authority with another, one company with another, or a local authority with a company, is in the want of uniformity in the systems of accounts and practice.

In the case of local authorities—who are in the position of trustees for the public, whose money they speculate with—there should be absolute rules as to the principles upon which the accounts are kept, and a strict Government audit for the protection of the public.

As an instance of what is possible under the existing system, take the case of Plymouth, where it has been shown that the financial affairs of the Corporation have been so mismanaged that there is no means of ascertaining whether money has been spent for the purposes for which the loans were raised.

In making comparisons between the results of the trading in London, the County Council return deals with the average prices obtained for the supply of current, and points out that these are generally lower in the case of the local authorities than the companies, inferring, of course, that this proves how the public are better served by municipal trading than by private enterprise.

But it really proves nothing of the kind. If the users of electricity, for example, pay too low a price to the local authority, and the general body of ratepayers have to make up a deficiency in the accounts, it is a loss to the community, although a gain to the small percentage of those who are consumers; whereas a company may obtain a higher price, pay a dividend to their shareholders, and prove to be the soundest traders, while doing no wrong to the general public.

The table we are referring to averages prices obtained by undertakings which have been working from *one* to *sixteen* years, and under all sorts of conditions. The compiler points out the economical factors governing successful working, such as the advantage of supplying public lighting, obtaining a motive power load, &c., but he does not refer to the fact, that of the 13 districts in which there is any public lighting by electricity, local authorities supply eight of them at prices ranging from 1·62d. to 3·44d. per unit, the five companies supplying the other districts at 1·93d. to 2·45d. Unfortunately, the accounts are not kept on any uniform system, as we find that in the case of the local authority of Poplar capital charges in respect of incandescent street lighting are included. Hammersmith, St. Pancras and Islington include capital charges in respect of public lamps, and the City of London Co., but not the other companies, include maintenance of public lamps.

The return of net revenue and disposal of surplus and the depreciation and reserve funds contain figures which may be carefully studied as proving to some extent the results of the trading, and, so far as the local authorities are concerned, should satisfy the public that trading in electricity by municipalities cannot be justified upon the plea that it "pays."

The accounts of 12 of the boroughs are included in the return, the other three possessing powers but not having yet worked them.

The total capital involved in the 12 undertakings in question amounts to £2,341,932.

The surplus, after payment of interest, is stated to be £24,824, and the depreciation and reserve funds amount to £35,439, which includes the £3,600 penalty for delay in completing the works at Fulham, to which we referred in our former article.

These two amounts constitute the evidence placed at the disposal of the public as to the commercial results of the trading—viz., that upon a capital outlay of £2,341,932 £59,763 has been realised as profit, or, say, 2·55 per cent., but, as a matter of fact, no such margin exists, inasmuch as the depreciation and reserve funds are far below the amounts which should be provided to cover the loss of value by the wearing out of the plant, antiquation, and the contingencies constantly occurring in working electric undertakings.

If we take the very moderate estimate of 3 per cent. to meet these purposes, it would require £70,258—which means that there has been an absolute loss upon the trading apart altogether from the repayment of the capital by the sinking fund—which constitutes a demand upon the ratepayers until the balance of revenue is sufficient to meet all liabilities, inclusive of the depreciation and reserve funds.

The repayment of loans by the municipalities is shown to have been exceedingly small—viz., 1·08 per cent. Consequently there is an enormous amount of indebtedness to clear off before those halcyon days when municipal trading in electricity will be the means of reducing the burdens upon the ratepayers. Bentley said that "no man can expect eternal serenity and halcyon days from so incompetent and partial a cause as the constant course of the sun in the equinoctial circle," and we are disposed to say that the very incomplete competency of local authorities in the management of electrical undertakings is quite unlikely to secure for the ratepayers that eternal serenity which would follow the payment of their rates as the outcome of such examples of municipal trading.

The action of Parliamentary Committees in endeavouring to protect the ratepayers by regulating the trading, so as to fix prices that shall cover the outlay, is practically impossible.

The principle involved in what is known as the "Bermondsey" clause admits the doctrine that municipal trading in electricity, whether in the supply of energy for tramways or general purposes, must not be carried on at a loss. How will this act?

At the end of the first year losses are always incurred, and the operation of the clause would be to raise prices, with the inevitable result that the trade would be paralysed.

But if municipalities are to work upon the principle of "no losses to be allowed," it is obvious that the accounts must be strictly audited and the question of depreciation dealt with.

Take the case of Brighton, referred to by our correspondent, Mautby Hill, in our last issue, "No depreciation fund and not a penny paid out of the electricity undertakings towards the support of the establishment charges of the Corporation," and yet the advocates of municipal trading try to keep up their courage by constantly whistling the tune, "It pays—it pays."

ELECTRICITY v. COMPRESSED AIR.

By T. CAMPBELL FUTERS.

From a criticism published in a recent issue of the *Engineering and Mining Journal* upon a paper by Mr. W. B. Clark on "Electrical Apparatus for Coal Mining," there appears to be as much diversity of opinion on the use of "electricity in mines" in America—the boasted home of electrical invention—as on our own side of the herring pond.

Mr. Saunders, the author of the criticism in question, goes strongly in for compressed air, and condemns electricity because it seems he has "searched in vain for a standard mining equipment where electric rock drills are in constant commercial operation," which is very probable. But rock drilling is only one (and not the most important) operation in mining, and when he goes on to say: "Air is exactly what is wanted in such a mine (coal mine) and electricity is what is not wanted, "The one is safe and healthful, the other dangerous and destructive;" and, further, quotes the Report of Bureau of Mines which says: "Besides the increase in danger from explosive gases, other elements have been introduced into mines by the use of mining machines and electricity. These have been introduced during the past 10 years, and it is the opinion of the writer that the use of electricity in any form in coal mines is a menace to life, limb, and property;" both he and the "Bureau" are talking nonsense. Then comes further extracts from the "Bureau" on fatalities caused by the "*deadly wire*," and finally Mr. Saunders raises the "sparking bogey," which has been made so much of in our own country.

The superiority of electrical efficiency over that of compressed air, Mr. Saunders does not seem to seriously question, and admits that the efficiency of an air locomotive, for instance, is only "20 to 30 per cent.," but denies (without any evidence however) that the efficiency of an electric locomotive is 55 per cent.

In England, underground locomotives are rarely used, and there is probably not a *single* air locomotive working in any English colliery. They have been tried, but were not a success. In America, however, they seem to go in for "locomotive" haulage, whereas here, rope haulage has proved to be the best, and Mr. Saunders goes on: "As to the pneumatic mine locomotive, the statement is made that it 'is not an unqualified success,' and among the reasons given are that its radius of operation is restricted. A mine locomotive which is absolutely restricted to the limits of a trolley wire would seem to have a more limited radius than one which is independent of any wire or connection, which carries its own power stored in tanks and which might go anywhere and on any track to the *extent of its storage capacity*." (The italics are the writer's.) Quite so! but to increase the storage capacity it would be necessary to lay pipes and probably a receiver or reservoir for re-charging, and the question becomes, Is it easier or cheaper to do this than to run a couple of overhead conductors?

Then as to cost of working, Mr. Saunders gives some figures which, in the writer's opinion, are glaringly misleading, as it is obviously unfair to compare one plant dealing with *2,362 tons per day* with another of only *989 tons* per day, as the fixed charges with a large output come out so much less, and one naturally expects to have a much lower *cost per ton* on a large output than a small one. As it is, the figures given are $0·01015 for compressed air, and $0·02192 for electricity.

Reverting, however, to efficiency, a subsequent issue of the *Engineering and Mining Journal* contains a letter by Mr. Winslow, also a supporter of compressed air—who in describing an electrical rock drilling installation, says: "All our power is supplied through our electric power line. There is undoubtedly *great economy in power with electric drills* under such conditions over what would be necessary with air drills, the former requiring directly, possibly, as little as *one-tenth* of the latter." The italics are the writer's, and if an electric rock drill can be driven with one-tenth of the power required for compressed air, is it too much to expect an electric locomotive to give an efficiency of 55 per cent.?

Mr. Saunders, however, is quite right in his contention that efficiency ought not to be taken in its restricted meaning of the proportion of the power generated to that given out as useful work, but in the capacity to get through work in the cheapest and quickest manner possible. A saving of nine-tenths in power, therefore, by adopting electricity, and consequent less first cost, goes a long way towards securing the former, and it only needs experience and improvements in mechanical details to secure the latter condition. This is already established with coal-cutting machines; even in America electrical machines are displacing those operated by compressed air, as is instanced, to again quote from the *Engineering and Mining Journal*, by the Chief Mine Inspector of Ohio, who says: "But while the machines depending upon electricity for power are becoming more popular and are more generally used, those operated by compressed air are becoming fewer. In 1899 the compressed air machines numbered 44; in 1898, 58; in 1897, 69; in 1896, 79; in 1895, 86; and in 1894, 112."

Generally, there can be no question as to the superiority of electricity over compressed air for use in mines, and as to

danger, no serious accident due to an electric spark or overheating, as had been anticipated, has occurred, in spite of inexperience and much inferior design and workmanship; on the other hand, whilst compressed air receivers have exploded, and though remote, this danger still remains, to say nothing of the annoyance, trouble and loss caused by the formation of ice, leakage of pipe joints, &c.

As the risk of breakdown, cost of maintenance, &c., depends upon the design, quality of material and workmanship of the installation, discussion as to the relative advantages of the systems in this respect is not of much use.

THE FIFTH INTERNATIONAL CONGRESS FOR APPLIED CHEMISTRY, BERLIN, JUNE, 1903.

[Reports of the Inaugural Meeting and of the Proceedings of Section X. (Electro-Chemistry), by our Special Correspondent.]

(Continued from page 973.)

Wednesday, June 3rd.

The morning session of the Congress on Wednesday, June 3rd, was the first full sitting of all the members, and the assembly, which numbered nearly 2,000 and filled the Deputies Chamber of the Imperial Parliament House in Berlin, was probably the most representative gathering of chemists which has ever been seen within one building. Prince Frederick Henry of Prussia represented His Majesty the Emperor of Germany, and remained for the whole of the proceedings; while Count von Posadowsky and Dr. Studt were present on behalf of the State Authorities, and gave an official welcome to the members of the Congress. The proceedings at this inaugural meeting of the Congress lasted one and three-quarter hours, and consisted entirely in the reception of the official representatives of foreign governments and of various chemical societies and industries. Each of these representatives delivered or read a short address, and the occasion was remarkable for the variety of language and accent which it called forth. Undoubtedly the President of the Congress, Dr. Otto N. Witt, is well fitted for the position which he occupies. Nature has provided him with a commanding presence and a voice which can be easily heard in every corner of the Reichstag Assembly Hall, and to these advantages he has further added by becoming an accomplished linguist, able to express himself in German, French or English, with an almost irreproachable accent. The representatives of the English Government and of English Scientific Societies:— Prof. Tilden, of the Royal College of Science, and Mr. Ivan Levinstein, of Manchester, both spoke in English. Prof. Moissan, of Paris, and Prof. Paterno, of Rome, were received with great applause, and addressed the assembly in their native tongues.

The actual work of Section X, commenced with the afternoon Session of Wednesday, June 4th, at 3 p.m., in the Lecture Hall of the Physical Institute of the University of Berlin. This departure from the rule that all sectional meetings should be held in the committee rooms of the Reichstag building was made in order to accommodate the numbers expected to attend the sittings of Section X., and it is well that it was so planned, for fully 300 members appeared at this opening meeting of the Section.

Dr. Böttinger, president of the Section, opened the proceedings with a few words of greeting, and the first paper presented was an account of experimental work undertaken by Prof. Traube and Herr Teichner, of Berlin, in relation to critical density determinations. The value of the constant (b) in Van der Waals formula for calculating the critical temperature for any liquid or substance, has been found by these observers to vary; in other words, the volume of the molecule is not a constant, but increases in its passage from the liquid to the gaseous state. By an ingenious application of very minute graduated glass floats enclosed in a sealed tube containing the liquid under pressure, the authors of the paper were able to show the audience that after the meniscus had disappeared within the tube, differences of density still existed in the gaseous mixture which filled it, these differences being indicated by the various levels occupied by the glass floats. The temperature and pressure used in these experiments were about 290° C. and 40 At. respectively. This demonstration of a very difficult experiment gained much applause, but the theory which the authors had advanced to explain it met with some adverse criticism.

The chief feature of the opening sitting of Section X. was, however, the lecture by Prof. Nernst, of Göttingen, which followed Prof. Traube and Herr Teichner's demonstration. Prof. Nernst detailed with remarkable clearness, and with a few experiments, the method which he has worked out and applied with some success, to the determination of vapour densities at very high temperatures. Until this method had been worked out and successfully applied, all vapour density determinations had been confined to temperatures within the melting limits of the glass vessels in which they had been carried out—and the difficulties that had confronted those who had attempted to find a suitable substitute for glass had proved insurmountable. In the first attempts made by Prof. Nernst a mixture of zirconium and yttrium was used for constructing the special tubes in which the vapour density determinations were made, the principle of the Nernst lamp being employed in order to render these tubes conducting, and to attain the high range of temperature demanded. (An experimental demonstration was given of this method of attaining in a few moments a very high temperature.) For various reasons this method of carrying out the desired determinations failed, and a tube of pure iridium (the most infusible of metals) was then constructed by the firm of Heraeus, in Hanau, for the further experimental work. The vapour density determinations were carried out in this tube by the well known method of Victor Meyer, the iridium tube being heated in an electric resistance furnace of special construction. For temperature determinations a special photometric method was employed, which gave results with a + or − error of less than 30° C. For weight determinations, a balance of special construction was also employed. This balance admitted of weight determinations being made, with a + or − error of only $\frac{1}{10000}$th of a milligram. The temperatures at which most of the determinations made by Prof. Nernst were carried out, lay between 1,900° and 2,000° C., it being found inadvisable to proceed above the latter limit. At these high temperatures, practically every substance examined showed signs of dissociation into the atomic state, and in the case of sulphur, the figure obtained for the vapour density showed that 30 per cent. of the total weight present had been dissociated at the temperature employed.

By the use of an indirect method, a similar dissociation effect was also proved to occur in the case of oxygen. Prof. Nernst's lecture was delivered with extraordinary vivacity, and fully deserved the applause with which it was greeted.

The third, and as it proved final paper of the afternoon session, was by Dr. Fröhlich, of Messrs. Siemens & Halske, of Berlin, and dealt with a new form of electric resistance furnace. Dr. Fröhlich claims to have discovered the existence of substances or mixtures which lose their conducting power at high temperatures, and thus become available for use in the construction of electric resistance furnaces. The discovery is complementary (or contradictory) to that of Prof. Nernst, who was the first to note and make use of the opposite characteristic of certain of the rare earths in the well-known Nernst lamp. Dr. Fröhlich's paper gave rise to some discussion, and doubts were expressed as to the correctness of the theory underlying the construction of the new furnaces.

The authors of the three remaining papers down for reading at the first afternoon session of Section X. were not present when called upon, and consequently the audience dispersed after a sitting lasting only two hours.

At a meeting of the members of various English societies attending the Congress, held on Wednesday, at 1 p.m., it was resolved that the Congress be officially invited to hold its next meeting (in 1906) in London, Prof. Tilden and

Mr. I. Levinstein being charged with the duty of presenting this invitation to the final general meeting of the Congress on Monday, June 8th. The invitation was duly presented, but it was decided by a vote of 294 against 274 to hold the next meeting in Rome.

The London invitation was accordingly declined.

THE ELECTRO-MEDICAL INSTALLATION AT MIDDLESEX HOSPITAL.

At the beginning of the present year, the authorities of Middlesex Hospital established an installation of apparatus for the electrical treatment of disease. The installation has been set up in a temporary building erected in the forecourt of the hospital, and it is supplied from the street mains with a continuous current, which is available at 200 volts or at 100 volts. High-frequency currents are generated either by a motor transformer, or by the ordinary Tesla apparatus with condensers, spark gap, and step-up transformer. For treatment with light, there are two Finsen lamps, in which the light is supplied by a 1,000-candle arc with two carbon electrodes. The light is condensed by a lens which is kept cool by water circulation. The patient is generally placed in a chair in front of the lens. It has long been known that lupus can be successfully treated by a powerful light, and at the Middlesex Hospital such treatment has been as successful as elsewhere. The active element in the light is at the violet end of the spectrum, and a great economy would be secured in this treatment if violet and ultra-violet rays only were emitted by the source of light. An attempt to realise this ideal is made in the Leslie-Miller ultra-violet lamp, which is also included among the apparatus at the Middlesex Hospital. The arc, in this case, is formed between two steel points, but as it is excited by an induction coil, the volume of light emitted must be very small. The authorities are also making experiments with the Cooper-Hewitt mercury vapour lamp, for the generation of ultra-violet light. This is a very powerful source of violet and ultra-violet light, and better results may be expected from these experiments.

There are two 12-in. induction coils fitted with the Mackenzie-Davidson mercury break. These coils are principally used for exciting X-ray tubes, which are used for skiagraphic work, and also for the treatment of carcinoma, lupus, rodent ulcer, ringworm, and trachoma.

The equipment also includes the ordinary apparatus for Faradic and galvanic treatment and testing, and a light bath. There are also two trolleys, one in the hospital and the other in the cancer wing, fitted with coils for treatment and for skiagraphic work. The temporary building is divided into waiting room, consulting room, dark room and dressing room.

The treatment of cancer with X rays appears to have been the most successful; but there is little evidence, as yet, that the improvement effected in this way is permanent. Very poor results have been obtained with the high frequency currents, which were so much in favour some time ago. The experiments of Jervis-Smith have shown that the intensity of these currents is immensely increased by compressing the air in the spark-gap. This device is worth a trial in the electro-medical treatment by high frequency currents.

There is no influence machine among the apparatus at Middlesex Hospital; but it is in great favour with electro-medical experts in the United States. It supplies a unique kind of current, not to be obtained from any of the other apparatus, and it is to be hoped that the authorities at Middlesex Hospital will also give it a trial.

Electro-medical treatment is still in the empirical stage, but careful experiments under the superintendence of properly qualified men may at any time lead to the discovery of some method of applying the electrical current which may result in the cure of hitherto incurable diseases. The enterprise of the authorities of Middlesex Hospital in setting up this installation is on this account to be commended.

FLY-WHEELS FOR DIRECT-CONNECTED ALTERNATORS.

Mr. Leavin, in the *American Machinist*, gives an approximate method for calculating the fly-wheel weights for direct-coupled alternators necessary to provide for a limitation of pole displacement angle, that is to say, the maximum attainable displacement of the poles from the position occupied were the speed constant throughout the revolution. He suggests that by means of a standard curve for each type of engine, a constant can be found pertaining to each class, which, worked into a formula, will give a fairly approximate answer.

The idea is to determine a coefficient for a curve constructed on the supposition of an engine of 1 H.P. run at one revolution per minute with a fly-wheel of 1 ft. radius.

He gives the curves Nos. 1, 2, 3, as annexed, of effort, velocity and displacement, the abscissæ representing time, and the whole length of the diagram the time of one revolution.

It is the maximum acceleration effort represented by the shaded portion that causes increase of velocity from a minimum to a maximum. Knowing what proportion of the work of one revolution this represents, the extreme velocity fluctuation will be—

$$\text{v max.} - \text{v min.} = \frac{C\,\psi\,\text{H.P.}}{R\,N^2\,W}, \quad (1)$$—where

v max. − v min. is the velocity change in feet per second of a point in the wheel distant R from the axis.

N = revs. per minute.

H.P. = horse-power at the cut-off at which ψ has been determined.

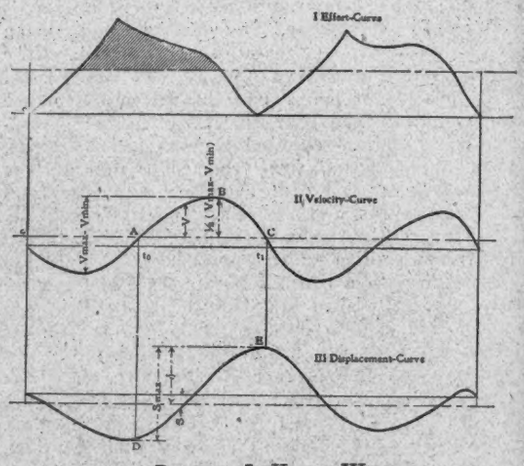
W = weight of revolving mass reduced to radius R.

$$C = \text{a constant} = \frac{33{,}000 \cdot g \cdot 60}{2\pi} = 10{,}000 \text{ approximately.}$$

$$\psi = \frac{\text{area of accelerating energy}}{\text{total area of diagram}}, \text{ or the coefficient of maximum fluctuation of energy.}$$

For single cylinder and tandem engines $\psi = 0{\cdot}12$ to $0{\cdot}16$; for cross-compound engines $\psi = 0{\cdot}05$ to $0{\cdot}14$.

It is assumed in the formula that v max. + v min. = 2 × mean velocity of the point in consideration. v max. − v min. is the depth from crest to hollow in diagram II.



Diagrams I., II. and III.

Curve 3 represents by its ordinates the distance of a pole ahead of or behind the angular position at the same time of the ideal pole of perfect constancy of speed, point D, a minimum point, showing where the pole lags, and point E where it leads. Point E, of course, coincides with the crossing of the mean velocity line by the velocity curve in diagram II., while point B of diagram II. coincides with the crossing of the mean line by the effort curve in diagram I.

It is now assumed that the distance, $t_0 - t_1$, is one-third of a revolution, or the speed above mean lasts for one-third of the total time of a revolution. It is also assumed that δ is $\frac{2}{3}$ of the maximum displacement, s, or $\delta = \frac{3\,s\,\text{max.}}{5}$. With these assumptions is obtained

$$s\,\text{max.} = \frac{2}{3}\left[\frac{1}{2}(\text{v max.} - \text{v min.})\right] \times \frac{1}{3} \times \frac{60}{N} = \frac{1}{9} \times \frac{60}{N}(\text{v max.} - \text{v min.})$$

and

$$\delta = \frac{4}{N}(\text{v max.} - \text{v min.})$$

and combined with formula (1)—

$$\delta = \frac{4\,C\,\psi\,\text{H.P.}}{N^3\,R\,W},$$

or

$$W = \frac{4\,C\,\psi\,\text{H.P.}}{N^3\,R\,\delta} \quad (2),$$

which fixes w at radius r necessary to preserve the deviation of the pole within the limit δ.

The ordinary fly-wheel formula for moment of inertia is

$$w r^2 = \frac{96{,}400{,}000\ \psi \text{ H.P.}}{N^3 K}$$

where K is the coefficient of fluctuation, usually chosen as $\frac{1}{30}$ to $\frac{1}{300}$ according to the nature of the work to be done. To keep within a limit δ, we get from (2)

$$w r^2 = \frac{40{,}000{,}000\ \psi \text{ H.P.} r}{N^3 \delta}.$$

Here δ is the length in feet measured on a circle of radius r. We get also

$$w r^2 = \frac{1{,}150{,}000{,}000\ \psi \text{ H.P.} P}{N^3 E},$$

where E is the fluctuation in degrees of phase, and P is the number of poles.

This last formula is the most useful in electrical work.

All depends on a proper choice of ψ.

THE NEW POWER HOUSE AT NIAGARA.

By ORRIN E. DUNLAP.

The present output capacity of the Niagara Falls Power Co. is 80,000 H.P. This is made up of the 50,000 H.P. installation in power house No. 1, and the 30,000 H.P. in power house No. 2, in which six new generators have been installed. When fully completed the output capacity of power house No. 2 will be 55,000 H.P., which means that an additional five generators will be installed, making a total of 11 in power house No. 2, or a grand total of 21 in the two big power houses.

The six new generators installed in power house No. 2 are of General Electric make, and the same company is to furnish the entire electrical equipment of the station. These six new generators are of particular interest, because the iron bridge over the generators in power house No. 1 has been omitted in building these latest Niagara power producers. The omission of this iron bridge results from the fact that the collector-rings of the new machines are placed at the bottom of the dynamo shaft instead of at the top.

Through the closer regulation, constancy of voltage on the system is ensured with variations of load, while the unbalancing of voltages on the different phases by differences in loads is reduced to a minimum. This result is an important factor at Niagara, especially to the Niagara Falls Power Co. While many systems of electrical distribution supply a large number of small consumers, the doings

Niagara New Power House.

of any one of which have but slight effect on the voltage, the Niagara Falls system supplies a small number of large consumers, and the change in load at any one of the plants might cause a marked disturbance on the circuits. In addition to this feature of the Niagara development, there is the further fact that single-phase electric furnaces are supplied with current taken from one phase, giving an inequality of load on the phase, and unbalancing the voltages. By the use of generators capable of close regulation the effects are made inappreciable.

In the new generators a different system of ventilation is employed than in the generators in power house No. 1. Air induced by centrifugal pressure enters the generator at the bottom side of the armature shell, passing outward through the air ducts in the

Power House No. 2 at Niagara.

The new generators are, however, of the external field type with the nickel steel revolving magnet ring. Each generator is of 5,000 H.P. capacity, wound for 2,300 volts, two-phase, 25 cycles, at 250 revolutions per minute. The new generators are capable of much closer regulation than the generators in power house No. 1, and this, with the fact that the entire plant of power house No. 2 will be operated from a single switchboard, and also the protection of the feeders with automatic oil circuit-breakers, form the main points of difference between the two installations.

armature core, and continuing outward between the layers of the field winding to a space at the back of the field coils, and out through holes in the magnet ring. Holes for ventilating purposes are also provided at the top of the ring.

The five other generators to be installed in power house No. 2 will be of the internal revolving field type, so that in the two stations the Niagara Falls Power Co. will have three types of generators. These five machines will be wound for 2,300 volts, two-phase, 25 cycles, and will make 250 revolutions per minute;

they will be of 5,000 H.P. each. It will be possible to operate all the machines in parallel, and the current of the two power houses will be interchangeable.

The exciter plant of power house No. 2 has been installed in a chamber excavated in the side of the wheel-pit. The equipment consists of four 150-KW. compound-wound vertical shaft 220-volt exciters, each of which has its individual turbine placed directly underneath. The speed is 750 revolutions per minute, each exciter turbine having its own governor.

In general appearance power house No. 2 resembles the original station of the Niagara Falls Power Co., but several features have been added to increase its beauty. The building is of stone, and stands over wheel pit No. 2. This wheel pit is on the opposite side of the inlet canal to wheel pit No. 1, and nearer the river. A connecting tunnel 130 ft. below the surface allows the employés to pass from one pit to the other under the inlet canal. A new feature in connection with the new station is a covered forebay structure which extends along the canal side of the power house, and is about 40 ft. wide. The water enters the forebay from the inlet canal through arches, the tops of which are below the surface—a fact that should aid in preventing ice and drift troubles. Before passing to the penstocks, the water passes through racks. The wheel pit is 178½ ft. deep, 18½ ft. wide, and 463 ft. 8 in. long. Eleven turbines of 5,000 H.P. each will be installed in the pit.

These turbines are made by the I. P. Morris Co., of Philadelphia, but designed by Escher, Wyss & Co., of Zurich, Switzerland. The governors were built by A. Falkenau, of Philadelphia, after designs made by Escher, Wyss & Co. The turbines in wheel-pit No. 1 are double wheels, while those in wheel-pit No. 2 are of the internal discharge type, the discharge water being carried off through draft tubes. The new wheels are said to give an increased efficiency of about 10 per cent.

When the installation of power house No. 2 is completed, the Niagara Falls Power Co. will have 105,000 H.P. at its command, 50,000 of which will be generated in station No. 1 and 55,000 in station No. 2.

SOUTH AFRICAN NOTES.

(From our Special Correspondent at Johannesburg.)

May 18th, 1903.

Johannesburg.—Major O'Meara has agreed to act for the Council in opening the tenders called for in connection with the tramway and lighting scheme, and Lord Monkswell, the chairman of the London County Council, has kindly consented to co-operate with him in the matter. Owing to numerous protests from local firms as to lack of time, the Town Council has extended the time for delivering tenders for the supply of materials for the construction of the permanent way for the tramways, by one week. All tenders must reach Messrs. Mordey & Dawbarn, in London, by June 15th.

Capetown Section of the I.E.E.—At the monthly meeting of the local section of the I.E.E., Mr. J. P. Edwards in the chair, an interesting evening was spent, a fair attendance of members being present. The first paper for discussion, namely, "Phenomenon of Resonance in Electrical Circuits," by Mr. M. B. Field, was ably dealt with by Mr. Horne, who carefully elucidated the principal points of interest in the paper. The observations, said Mr. Field, made by the aid of the oscillograph, showed how that instrument played the same part to the electrical engineer that the indicator and its diagrams played to the steam engineer, and by its use knowledge was gained as to when cables were at their greatest stress, thus enabling precautions to be taken accordingly. Mr. Wilms brought forward instances from his practical experience, showing how that knowledge could be usefully applied to the safe-guarding of power systems, particularly in relation to the lightning effects.

The next paper, on the "Nernst Lamp," by J. Stottner, was also dealt with by Mr. Horne, who, by means of slides, exhibited details of the apparatus and diagrams of results. Mr. Banham and other members continued the discussion, and some of the Nernst lamps were shown in operation.

Mr. Banham exhibited and described a combined ammeter and voltmeter set arranged in portable form by Messrs. Elliot, of London. The apparatus, he said, permitted of a very wide range of observation, and the indications were shown to be admirably dead-beat.

Specimens of recent forms of telephone cable for aerial and underground purposes were shown by Mr. Parsons.

It was announced that on Wednesday the 30th inst., the section would visit Camp's Bay power station, at the invitation of the tramway company.

Volksrust.—Residents complain that the electric light scheme appears to have been "shelved." Like numerous other small Rand townships, the place is badly in want of some kind of illumination.

Durban, Natal.—The revenue from the electric trams during the month of April was £7,853, an increase of £2,300 over the revenue for the corresponding period last year.

The Working of Deep Levels.—The great problem which many of the Rand engineers are now facing, is the successful development and economical working of mines at depths of from 6,000 to 7,000 ft.

The most important point, indeed the only real one, is that of an efficient winding plant. This subject has been thoroughly and exhaustively dealt with in a paper recently read before the South African Association of Engineers, by Mr. H. C. Behr, the consulting mechanical engineer of the Consolidated Goldfields of South Africa, Ltd. Remarks were made in the discussion by Mr. Hennen Jennings and Mr. A. M. Robeson, of Messrs. Eckstein, Ltd. Mr. Behr's contention is that the most feasible system is one of electric winding, and his conclusions show that for depths not over 4,000 to 4,500 ft. hoisting in a single lift is preferable to stage winding, and that two stages will suffice for depths of 7,000 ft. The question of drilling and ventilating at these depths is easily within the scope of electricity. The paper and discussion are to be published in conjunction with the *Journal* of the Institute of Mining and Metallurgy, and engineers at home interested in the Rand mining industry should not neglect this opportunity of consulting such authorities as those quoted.

Installations on the Rand.—Recent reports and balance-sheets show the value of electrical plant in the undermentioned mines:—New Unified Main Reef G.M. Co., £454, £117 having been written off as depreciation. New Primrose G.M. Co., £6,220; written off, £916. Glencairn M.R.G.M. Co., £84,000. Ginsberg G.M. Co., £3,080; written off, £795.

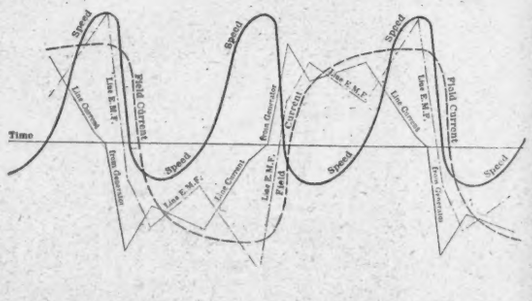
Dissolution of Partnership.—The firm of Messrs. Oehman and Hoppert, electrical engineers, instrument makers, &c., has dissolved partnership, and the whole of the plant, stock, &c., is to be sold by auction on the 28th and 29th inst.

THE ACTION OF A SHUNT-WOUND MOTOR WHEN DRIVEN BY A SERIES-WOUND DYNAMO.

There is no difficulty in running series-wound motors from shunt or compound-wound dynamos, but the reverse operation presents some interesting phenomena. In the *American Electrician* (February) A. S. M'Allister discusses these.

If a separately-excited motor be run "light" from a series dynamo, it will run first in one direction and then in the other. This is due to the fact that as the back E.M.F. of the motor rises the dynamo loses its field. The motor running on a little by its own momentum acts as a generator and reverses the dynamo, which then pulls the motor up and reverses it. The cycle is then repeated.

With a shunt-wound motor connected up in the usual way, the action is somewhat more complicated. The motor reverses as before, but from a different cause. The curves in the figure have been plotted from observations made on such an arrangement. From these curves it will be noted that the field current lags behind the E.M.F. on the terminals of the winding. The field magnetism also evidently lags behind the field current, as might naturally be



Curves of Pressure, Current and Speed.

expected, owing to hysteresis. [This is an old fallacy.—Eds.] If the field reversed at the same time as the armature, no reversal of rotation would take place, but, as the armature current changes first, the moor reverses; then when, after a little while, the field reverses, the motor stops and reverses again to its original direction of rotation, and so on.

If the curves be carefully traced out the action will be understood without a detailed description of the operation.

It may, however, be pointed out that the hysteresis of the magnet cores and the self-induction of the exciting coils are not the only phenomena that contribute to the repeated reversals of the motor. Whilst the motor acts as a dynamo, it excites its shunt in the same direction as the generator did previously. This, of course, causes the armature to slow down, and the field drops with the speed. Meanwhile the generator armature has become reversed, but no reversal of direction would take place if the motor field reversed at once, so it is really the self-induction of the coils and the hysteresis of the cores which are responsible for this. If a load were put on the motor such that the speed fell quickly, after the torque became zero, the counter E.M.F. would never overcome the impressed E.M.F., and the motor would not reverse.

Wednesbury Tramways.—The Corporation has now come to terms with the South Staffordshire Tramways Co. and the South Staffordshire Tramways (Lessee) Co., for the purchase and lease of the tramways undertaking in the borough.

EBEL'S MORSE TELEGRAPH INSTRUMENT.

This recording style and pocket sounder has been designed to promote accuracy of transmission at a minimum cost by furnishing a permanent record of all signals sent, and is being manufactured by Messrs. Siemens Bros. & Co., Ltd.

Fig. 2 shows the style, which is identical with a Morse contact key, having body, marking and spacing contacts. It consists of a tubular casing which contains a blade spring body, B (with contacts), terminating in a tracing point. The blade spring is adjusted to rest permanently on the spacing contact, S, when the style is not in use. The marking contact, M, is placed opposite to S, so that when pressure is applied to the tracing point in use contact is made with the blade spring at M.

All three contact parts are separately connected to a flexible triple leading wire. The other end of the leading wire is connected to a three-way plug and socket, which may be mounted on the base of any Morse inker or sounder, and internally connected with the instrument. This allows the operator to connect at will, and use the Morse key or the style as desired. The style should be held like a pencil, taking care that the white knob which indicates the direction of the marking contact is uppermost. The dots and dashes should be marked across the paper, as shown in fig. 1.

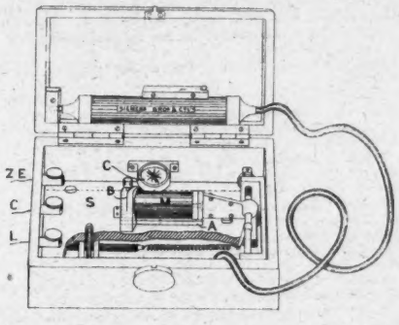


Fig 3

Fig 1.

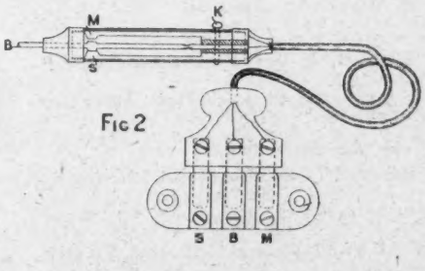


Fig 2

The records may be taken by using metallic paper, or plain paper with carbon sheet may be employed; and by using several sheets, as many actual records of transmitted signals may be retained as desired. This style is also employed in the Ebel portable telegraph apparatus or pocket sounder.

Fig. 3 shows this apparatus. The electro-magnet has a single iron core attached to a swinging lever, with spiral spring and adjustable screw attachment. The armature A, and the bridge B, are both attached to the sounding board S. The movement of the armature is limited by means of the adjustable screw.

A small compass needle, N, is attached to the side of the box in close proximity to the electro-magnet.

The recording style is connected internally by means of the flexible triple wire, and the connecting terminals, Z, E, C, L, are used for the outside connections.

The novelty of this apparatus consists chiefly in its compactness and small weight, the special combination enabling a complete outfit for an end station to be placed in a case not larger than 4½ in. × 2⅝ in. × 2¼ in., of the weight of about 12 ozs.

The whole outfit comprises:—Sounder; current indicator; sending key, *i.e.*, style for recording signals transmitted; sounding board; and connection terminals. The combination is recommended as a particularly handy one for field service, and for line and cable repairing, &c.

The sound produced by the instrument is very clear and distinct.

Mr. J. Ebel, who is one of Messrs. Siemens's engineers, is also the inventor of the Ebel relay and other instruments.

OUR LEGAL QUERY COLUMN.

[Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.]

"R. R. S." writes:—"Will you kindly inform us, through the medium of your paper, whether the Board of Trade order for Municipal Electric Lighting undertakings sanctions all change-over work in consumers' premises—such as changing holders, ceiling roses, switches, fuses, &c., when changing from 100 volts to 200 volts pressure, or should this be given out to contractors? We believe we are right in saying that it does not allow them to wire any premises, or to pose as contractors otherwise than for the supply of current and the loan of meters and their own feeders."

*** The question put by "R. R. S." cannot be answered without reference to the order under which the municipality of his district supplies electric light; the right to supply electric fittings being one of the privileges which is conferred upon some local authorities who supply electricity and not upon others. We may, perhaps, mention that by the 62 and 63 Vict. c. ci., sec. 40, the Nottingham Corporation are empowered to provide and let, &c., but not to manufacture, "lamps, meters, electric lines, fittings, apparatus, and things for lighting and motive power, and for all other purposes for which electric energy can or may be used, or otherwise necessary or proper for the supply, distribution, consumption, or use of electric energy." It is presumed that if the municipal authority in question happens to be vested with powers of this kind, the right to supply will include the right to erect the electrical fittings. "R. R. S." can probably obtain a copy of the prov. order and the Act confirming the same from Messrs. Eyre and Spottiswoode, London, E.C.

"Lessee" writes:—"Have the National Telephone Co. any legal right to attach their wires to private property without the owner's consent, or to run wires over any garden land attached to private property without leaseholders' consent? What course should be taken to compel them to remove, failing their right to cross. Is not a lessee of land entitled to object to any wires crossing above even a corner of his land?"

*** It is provided by Sec. 21 of the Telegraph Act, 1863, that a telegraph (which term now includes a telephone) company shall make full compensation to the owner, lessee and occupier of any land or building over, along or across which the company places a wire and which may be shown to be in any respect prejudicially affected thereby, the amount of such compensation to be determined in the manner provided by the Lands Clauses Acts. If the company place a telegraph wire above ground or a post within 10 yds. of a dwelling house, or place a telegraph wire above ground, across an avenue, or approach to a dwelling house, without the consent of the occupier, they may (by Sec. 22 of the Act) be subject to a fine not exceeding £5 a day. If any question arises between an owner and the company, it is to be referred to the determination of two justices, which justices may give such directions as to the removal and time and mode thereof as may seem reasonable. In addition to this the company may be held liable for any damage caused (Sec. 42). So far as can be ascertained these provisions apply to the National Telephone Co., although they act under the license of the Postmaster-General. In these circumstances it is conceived that "Lessee" could go to the police court to obtain an order for the removal of the wires. It is anticipated, however, that he would find it better to come to terms with the company, who will probably do everything that is reasonable in the matter.

THE ENGINEERING CONFERENCE.

On Tuesday evening next, June 16th, Mr. W. H. Maw is to deliver the eleventh "James Forrest" lecture at the Institution of Civil Engineers, the subject being "Some Unsolved Problems in Engineering," and on the following morning the "Engineering Conference" will be inaugurated by Mr. J. C. Hawkshaw, the president of the Institution, with a short address. The conference will then, according to the general custom, split up into seven sections, and the proceedings will continue over three days, closing on Friday, June 19th. The following are the sections arranged for:—(1) Railways (chairman, Sir Guildford Molesworth); (2) Harbours, Docks and Canals (chairman, Sir Leader Williams); (3) Machinery (chairman, Dr. Alex. B. W. Kennedy); (4) Mining and Metallurgy (chairman, Mr. E. P. Martin); (5) Shipbuilding (chairman, Sir J. I. Thornycroft); (6) Waterworks, Sewerage and Gasworks (chairman, Sir Alexander Binnie); (7) Electricity (chairman, Mr. Alexander Siemens). From a copy of the programme which has been sent to us by Dr. Tudsbery, the Institution secretary, we note that there are to be papers of more or less electrical interest read in most of the sections. On the Wednesday the Machinery and Electricity sections are to consider together two papers, viz., one by Mr. H. A. Humphrey on "Internal Combustion Engines for Driving Dynamos," and one by Mr. H. J. Marshall on "Gauges and Standards as Affecting Shop and Manufactory Administration." On Friday, June 19th, the Railways and Electricity Sections will join together in the discussion of two papers on railway electrification—*i.e.*, "High-speed Electric Traction on Railways," by Mr.

J. W. Jacomb-Hood; and "The Position and Protection of the Third Rail on Electric Railways," by Mr. W. E. Langdon.

The other papers of electrical interest are as under, the bracketted figures indicating in which section they are to be read:—

Wednesday, June 17th.

10 a.m.—President's address to all sections.

"The Design of Permanent Way and Locomotives for High Speeds." Mr. James C. Inglis. (I.)

"Automatic Signalling." Mr. W. J. Cudworth. (I.)

"Speeds of Overhead and other Cranes as a Factor in Economic Handling of Material in Working." Mr. Archibald P. Head. (III.)

"Internal Combustion Engines for Driving Dynamos." Mr. H. A. Humphrey. (III. and VII.)

"Gauges and Standards as Affecting Shop and Manufactory Administration." Mr. H. J. Marshall. (III. and VII.)

"Percussive Coal Cutters." Sir Thomas Wrightson, Bart., M.P., and Mr. John Morison. (IV.)

"Recent Improvements in Gold-mining Machinery on the Rand." Mr. Arthur E. T. Lees. (IV)

"Steam-driven and Gas-driven Blowing Engines." Mr. Tom Westgarth. (IV.)

"Wireless Telegraphy." Mr. E. A. N. Pochin. (VII.)

Thursday, June 18th, at 10 a.m.

"The Organisation and Administration of an American Railway." Lt.-Col. H. A. Yorke, R.E. (I.)

"The Relative Advantages of Overhead, Deep Level, and Shallow Subway Lines for the Accommmodation of Urban Railway Traffic." Mr. S. B. Cottrell. (I.)

"The Use of Petrol Motors for Locomotion." Monsieur E. Sauvage. (III.)

"Apprenticeship in Engineering Education." Prof. J. D. Cormack. (III.)

"Smoke Abatement." Mr. G. T. Beilby. (VI.)

"Applications of Electricity to Driving Carriages in Towns." Lt.-Col. R. E. B. Crompton, C.B. (VII)

"Transmission and Distribution by Single-Phase Alternating Current." Mr. E. W. Monkhouse." (VII.)

Friday, June 19th, at 10 a.m.

"The Modern Equipment of Docks, with Special Reference to Hydraulic and Electric Appliances" Mr. Walter Pitt. (II.)

"Recent Improvements in Canal Engineering." Mr. Gerald Fitzgibbon. (II.)

"Alloys of Iron, Nickel and Manganese." Mr. R. A. Hadfield. (IV)

"Steam Turbines." Prof. A. Rateau. (V.)

"High Speed Electric Traction on Railways." Mr. J. W. Jacomb-Hood. (I. and VII.)

"The Position and Protection of the Third Rail on Electric Railways." Mr. W. E. Langdon. (I. and VII)

The following are included in the list of works to be visited:—Messrs. Crompton's works at Chelmsford; National Physical Laboratory; Tube Railway works at Finsbury Park; Brompton and Piccadilly Circus Railway works; Charing Cross, Euston and Hampstead Railway works; Baker Street and Waterloo Railway works; Chiswick power station of the London United Tramways; Central London Railway generating station at Shepherd's Bush; Wood Lane generating station.

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

11,804. "Improvements relating to the control of electric motors." The Johnson-Lundell Electric Traction Co. (R. Lundell, U.S.A.) May 18th. (Complete.)

11,816. "Improvements in electrically-controlled semaphone signals." Siemens Bros. & Co., Ltd., and L. M. G. Ferreira. May 18th. (Complete.)

11,629. "Improvements in electrical fuses." Siemens Bros. & Co., Ltd., and H. Berry. May 21st.

11,865. "Improvements in or in connection with electro-magnetic lifting apparatus." Steel, Peech & Tozer Ltd., and H. E. Bowan. May 25th.

11,887. "Apparatus for automatic destruction of rats or vermin by electricity." S. M. Tancred. May 25th.

11,898. "Improvements in and relating to electrolysing apparatus." E. L. Thorp. May 25th.

11,894. "Improvements in or connected with means for electrically igniting miners' safety lamps." W. Best. May 25th.

11,960. "Improvements in electric arc lamps." W. R. Ridings. May 25th.

11,907. "An improvement in electric arc lamps." H. S. Heath. May 25th.

11,921. "Improvements in and relating to electric welding." S. Z. de Ferranti. May 25th.

11,967. "An improved machine-made nose-piece for gas or electrical fittings." H. Allaway. May 26th.

11,998. "Improvements in automatic electric circuit breakers." H. Swanton. May 26th.

12,015. "Improvements in coin-controlled locks for telephone receivers." P. M. Justice. (The Controller Co. of America, United States) May 26th. (Complete.)

12,032. "Improvements in electrolytic apparatus and secondary batteries." J. Y. Johnson. (H. B. Ford, United States.) May 26th. (Complete.)

12,068. "An improved adjustable holder for electric lamps." F. W. Parkes and M. Sadler. May 27th.

12,078. "Improvements in electric pocket lanterns." C. Gloerfeld. May 27th.

12,081. "Improved process and apparatus for the production of metals of the alkali group by electrolysis." E. A. Ashcroft. May 27th.

12,082. "Improved process and apparatus for the production of metals of the alkali group and alkalies by electrolysis." E. A. Ashcroft. May 27th.

12,083. "An improved method and apparatus for agitating the contents of electrolytic cells or effecting systematic transference of portions of the contents from one cell to another." E. A. Ashcroft. May 27th.

12,091. "Improvements in means for enabling shades carried upon bayonet electric light lampholders to be easily and quickly removed." J. Harrington. May 27th.

12,093. "Improvements relating to electric traction systems." H. H. Lake. (L. T. Gibbs, United States.) May 27th. (Complete.)

12,105. "Improvements in automatic cut-outs for electric circuits." Siemens Bros. & Co., Ltd., and H. Berry. May 27th. (Complete.)

12,119. "A method of receiving electrical vibrations with the use of electrolytic cells." W. E. Evans. (Allgemeine Elektricitäts Gesellschaft, Germany.) May 27th. (Complete.)

12,146. "Improvements in multi-carbon electric arc lamps." A. Eckstein and A. E. Angold. May 28th.

12,174. "Improvements relating to trolleys for overhead electrical conductor systems." H. H. Lake. (E. Cantono, Italy.) May 28th.

12,189. "Improvements in or relating to wall plugs and similar electrical fittings." S. A. Hunter. May 28th.

12,194. "Apparatus for the production of electrolytic deposition." E. Muller. May 28th. (Complete.)

12,203. "Improvements in electric burglar alarms." B. F. Schubert. May 28th. (Complete.)

12,217. "Improvements in a winding for dynamo-electric machines." E. A. Carolan. (The General Electric Co., United States.) May 28th.

12,218. "Improvements in electric signalling systems for railways." H. F. Parshall and E. Parry. May 28th.

12,242. "Improvements in electric alarms for clocks." H. E. Ives. May 29th.

12,288. "Improvements in electric cables." Callender's Cable and Construction Co., Ltd., and J. O. Callender. May 29th.

12,300. "A useful device for use in connection with electric lamps." C. Curwen. May 29th.

12,301. "Improvements in and relating to electric arc lamps" J. W. Ewart. May 29th.

12,310. "Improvements in electric circuit controllers." E. A. Carolan. (The General Electric Co., United States.) May 29th.

12,311. "Improvements in electric steering gear." E. A. Carolan. (The General Electric Co., United States.) May 29th.

12,312. "Improvements in the manufacture of materials suitable for insulating and other purposes" E. A. Carolan. (The General Electric Co., United States.) May 29th.

12,313. "Improvements in electric meters." E. A. Carolan. (The General Electric Co., United States.) May 29th.

12,314. "Improvements in electric motor control systems, and switches therefor." E. A. Carolan. (The General Electric Co., United States.) May 29th.

12,315. "Improvements in electric motor control systems." E. A. Carolan. (The General Electric Co., United States.) May 29th.

12,316. "Improvements in electric rheostat switches and resistances therefor." The British Thomson-Houston Co., Ltd. (H. R. Sargent.) May 29th.

12,331. "Improvements relating to dynamo-electric machines." H. M. Hobart. May 29th.

12,335. "Improvements in or relating to electrical main switches." J. Booker and W. Sanders. May 30th.

12,365. "Improvements in life-saving apparatus for electric tramcars and the like." J. Greenhalgh. May 30th.

12,377. "Improved process and apparatus for the production of metals of the alkali group and alkalis by electrolysis." E. A. Ashcroft. May 30th.

12,379. "Improvements in and relating to electric fire alarms and thermo-indicators." H. Hawthorn. May 30th.

12,401. "Improvements in the electro-deposition of metals." C. E. Allan and S. O. Cowper-Coles. May 30th.

12,408. "Improvements relating to dynamo-electric machines." The Hon. C. A. Parsons and G. G. Stoney. May 30th.

12,409. "Improvements relating to brushes for dynamo-electric machines or the like." H. H. Lake. (La Societé Anonyme Le Carbone, France.) May 30th.

12,416. "Means and apparatus for economising the use of electric current." A. Blackman and J. Crowley. May 30th.

PUBLISHED SPECIFICATIONS, 1902.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

6,948. "Improvements in the 'feeder pillars' or above-ground boxes and in connection with electric supply mains." Callender's Cable and Construction Co., Ltd. Dated March 21st.

7,363. "Improved electrical resistance and the application therefor to a switch." Siemens Bros. & Co. Dated March 26th.

7,528. "Improvements in electrical switches." J. Tomlinson, H. Lomax and R. Lomax. Dated March 29th.

7,952. "Improvements in and connected with flexible electrical connecting cords." H. Oppenheimer. Dated March 21st.

7,954. "Improvements in electric water heaters." J. W. Ewart. Dated April 5th.

7,955. "Improvements in electrical measuring instruments." S. Evershed. Dated April 5th.

8,188. "Improvements in or connected with the controlling of electro-motors." P. Coote. Dated April 8th.

8,616. "An improved method of moving electrically the points on an electric tramway or railway." J. P. Tierney and J. Malone. Dated April 14th.

8,796. "Improvements in or in connection with electric controlling devices." H. C. Frollick. Dated April 15th.

9,057. "An improved method of winding for electric machines and appliances." R. Rougie. Dated

9,663. "Improvements in electric and other tramcars." T. Rhodes. Dated April 26th.

9,883. "Improvements in electrical rock drills or rock drilling machines." A. H. Gibson. Dated April 29th.

13,079. "Improvements relating to the laminated core of dynamo-electric machines." H. H. Lake. Dated

14,809. "An improved electrical high-tension switch." T. Henwood. Dated July 3rd.

17,334. "Improvements in and relating to electrical bonds between rails or like conductors." J. C. Fell. Dated August 6th.

17,885. "Method of and apparatus for producing currents of high frequency." R. Seiarf. Dated August 14th.

18,777. "Improvements in and relating to the trolley holders for overhead electrical conductor systems." A. Thode. Dated August 26th.